MACHINE DESIGN

PARTS • MATERIALS • METHODS • FINISHES

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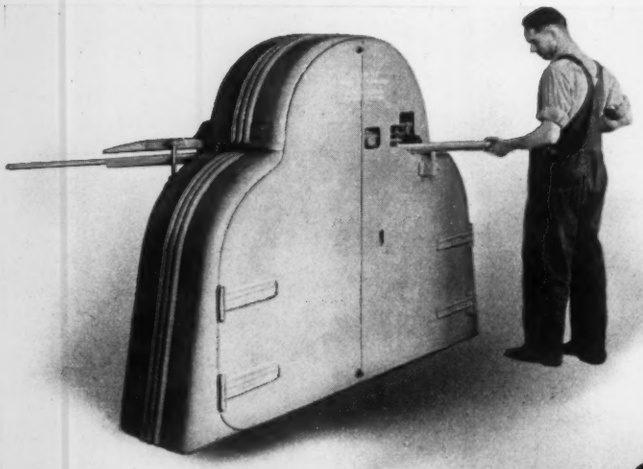

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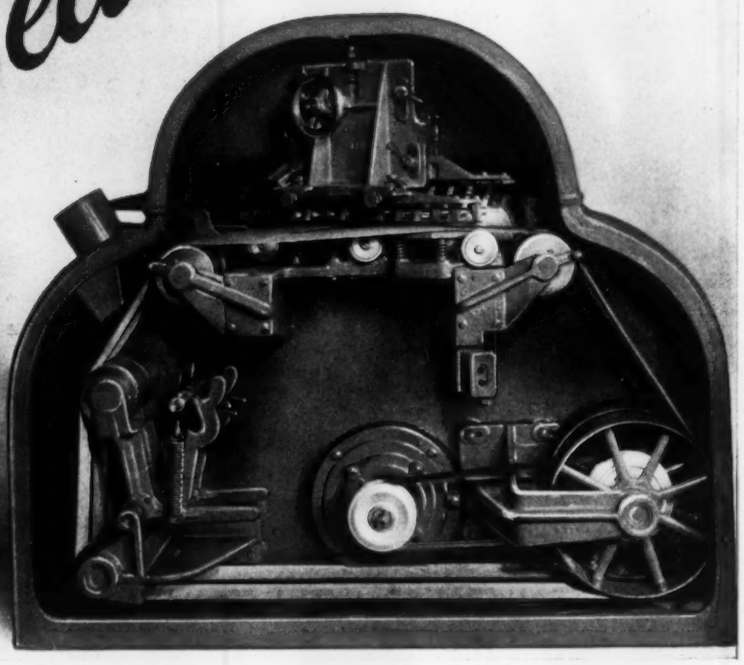

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2565 **THE *FORGED STEEL* BEARING**

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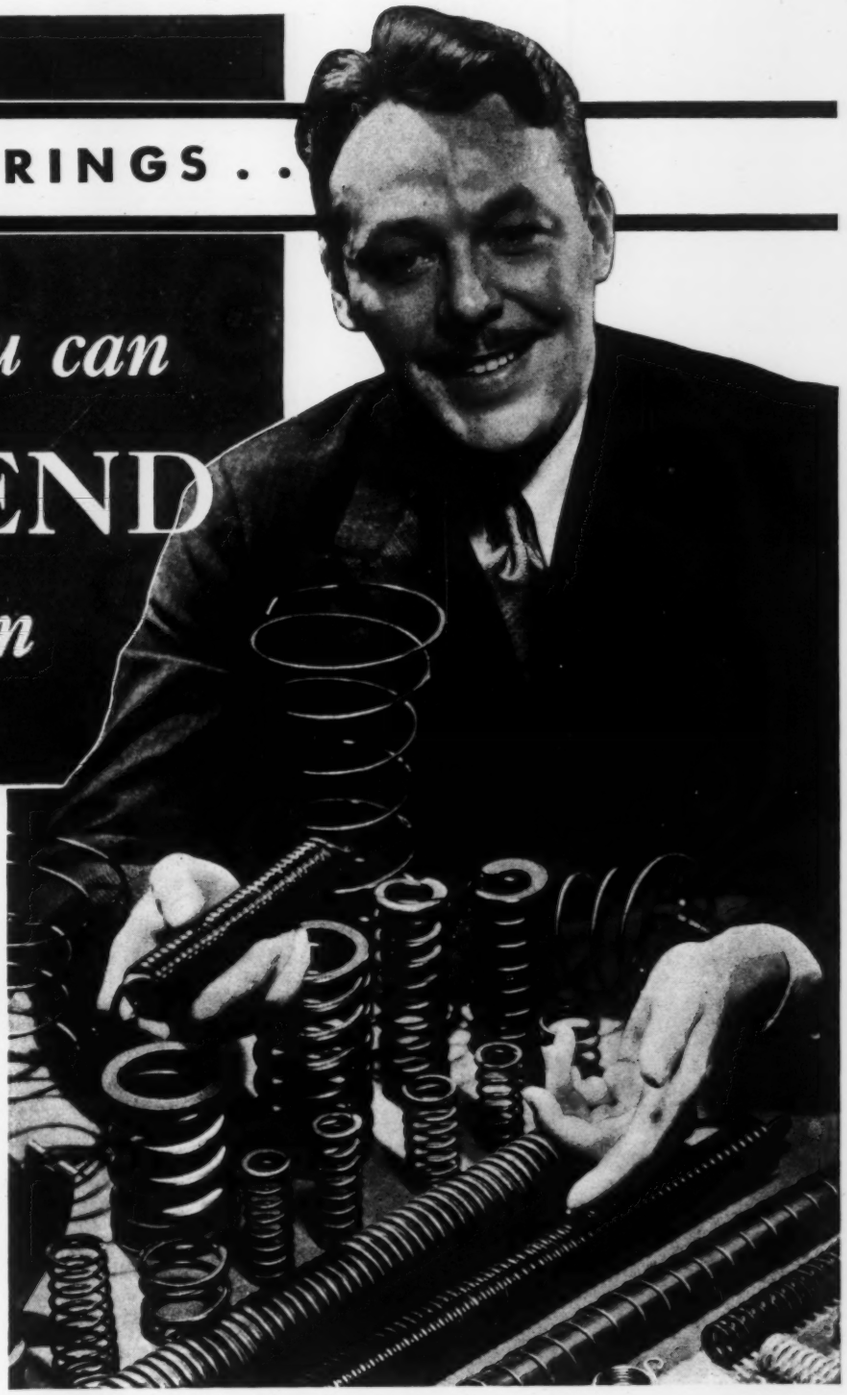

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TOPICS

ENGINEERS, generally speaking, are not a very mirthful lot. And of all engineers, those engaged in design of machinery are particularly solemn and reserved. Whether their innate character is responsible or they simply take themselves too seriously, is open to question, but we do feel that the occasional introduction of levity in the profession is desirable. For this reason we welcome the remarks of Arthur L. Townsend of the Massachusetts Institute of Technology who is endeavoring to find the funny side of machine design. In a recent issue of the bulletin of Machine Design Clearing House he relates a number of humorous anecdotes regarding machine design with the suggestion that a Division of Levity be introduced in design meetings. As a step in this direction, members attending the annual machine design dinner at the University of Wisconsin this year were entertained with a recital of funny situations or events occuring in machine design or applied mechanics classes. The annual affair with this innovation was exceptionally well received.

♦ ♦ ♦

Like the man who built a boat in his cellar too bulky to get through the door, engine builders are now specifying connecting rod bearings so large that if constructed in the conventional manner, the unit could not be withdrawn through the cylinder bore. Engineers, however, use more foresight than the boat builder. They have designed a connecting rod for use on diesel engines on which each side of the rod, where the bolt holes for the bearing cap ordinarily is located, is milled flat and provided with a groove into which one side of the bolt head fits. The bolts pass along the side of the connecting rod and through holes in the bearing cap, which saves at least ½ inch on each side of the rod. A transverse bolt and nut holds the two cap bolts from slipping out of the niches or grooves on the sides of the rod.

♦ ♦ ♦

Cleveland is becoming a center of still greater engineering prominence. Last month nine local men were honored as this year's heads of national engineering societies. Among them were James H. Herron, president of the American Society of Mechanical Engineers; A. M. McCutcheon, president of the American Institute of Electrical Engineers; Rollen Craten Allen, president of the American Institute of mining and Metallurgical Engineers, and Alfred E. Gibson, president of the American Welding Society. Recently elected head of the Cleveland Engineering Society, which honored these men, is Fred L. Plummer, professor at Case School of Applied Science.

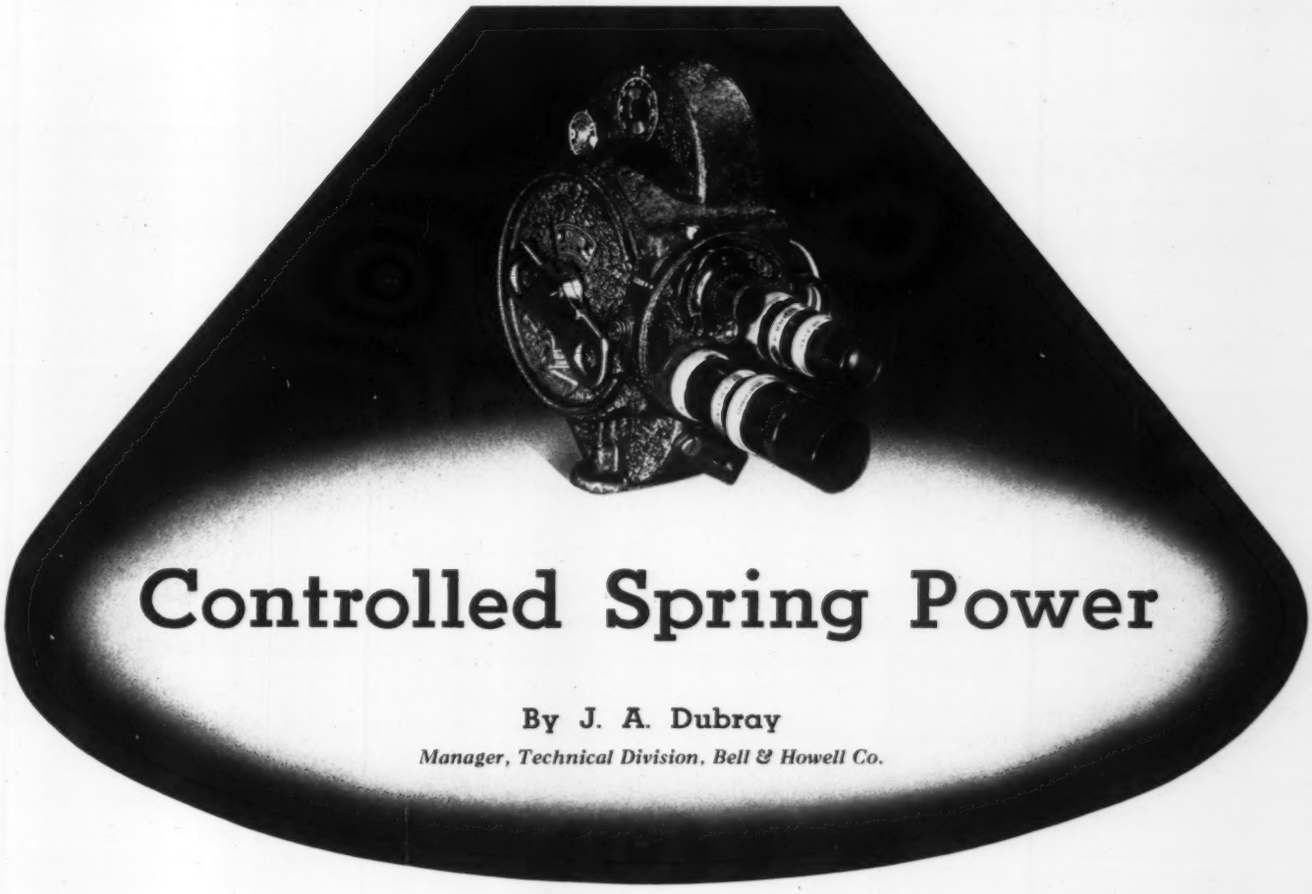
♦ ♦ ♦

Internal combustion engines reach wider extremes every day. We thought that a limit had almost been attained when engines for outboard motorboats were developed so small that one could be held while running. Now we find that tiny engines which can be placed in the palm of the hand are practical. Designed for model aircraft, these minute engines turn over at 1000 to 2500 RPM and are rated at 1/6 to 1/5 horsepower. The single cylinder of the one we saw is ¾-inch in diameter with a stroke of about ⅞-inch. Most of those being used here are made in Japan. Probably the next development will be gasoline engine to generate current for a flashlight!

♦ ♦ ♦

Strangely enough automotive engineers depend more upon experiment and much less upon analysis and calculation in solving design problems than do engineers in other industries, states C. J. Freund, of the University of Detroit, in a paper recently given before the A. S. M. E. In fact it is found, he says, that college trained men constitute only 58 per cent of the automotive engineering personnel as compared with 85 per cent of engineers in other fields. "Chief engineers of automobile concerns usually have no formal program for training college graduates, but the majority of executives insist that the college man work in the plant before coming into the engineering department."

MACHINE DESIGN



Controlled Spring Power

By J. A. Dubray

Manager, Technical Division, Bell & Howell Co.

ONE of the most essential factors in the successful functioning of an automatic spring-motor driven motion picture camera, is control of spring power to maintain uniform operating speed from start to finish of every "take." To make this clear, let us first consider briefly what the camera must do and the relation of its work to projection of films.

The impression of motion as given by projection of motion picture film on a screen is the result of rapid superposition of a great number of "picture frames." These are secured through a camera in which the images formed by a photographic lens are made to expose a ribbon of film moved intermittently at the camera frame aperture. The number of pictures exposed in succession each second is 16 for standard silent pictures and 24 for standard sound reproduction, the projection apparatus being designed to operate at either speed.

A camera constructed so that it can be operated at speeds other than the standard will allow a distortion of motion during projection. In other words, action can be made to appear either faster or slower than normal. The slower operating speed of the camera, which results in a greater speed of motion in projection, is used in practice to secure comical effects or to increase the exposure time on the film. This last

is sometimes necessary under conditions of light so poor that other means, such as the use of lenses of great aperture, are not sufficient to produce adequate exposure.

The faster operating speeds of the camera, which result in a slower speed of motion during projection, are used in practice whenever it is desired to analyze motion. This method of motion analysis is largely used in the field of sports and athletics. It also has proved particularly useful for the analysis of industrial operations, which may be either the functional operation of machinery and its component parts, or the motions of the operators themselves.

It is quite evident that in any and all cases the successful projection of pictures depends largely on the uniformity of the operating speed of the camera. This is true particularly when motion pictures are used for motion-timing studies. Engineers of Bell & Howell Co., recognizing this requisite, developed means of speed control for the "Filmo" Model 70-D 16-millimeter camera which show unusual ingenuity of conception and perfection of performance.

Problems in Motor Design

Power to operate the camera is generated by a spring motor. This must be designed to do the work that it is called on to perform with minimum friction and breakage possibilities combined with minimum weight and maximum efficiency. At the time when the spring is wound, there is stored up in it a certain amount of energy. This energy is released when the spring is permitted to unwind itself.

It is obvious that the expenditure of energy stored by the spring must be kept under rigid control. Two major problems were faced in effecting this. The first was to prevent the spring from operating beyond the point at which its torque becomes inadequate to impart sufficiently rapid motion to the camera mechanism. The second was to make the spring expend its stored energy uniformly throughout its effective working range. The solution of the first problem was reached by never allowing the spring to expend all of its energy. This was accomplished by an ingenious device which automatically stops the unwinding of the spring before its torque becomes inadequate to operate the camera at the required speed.

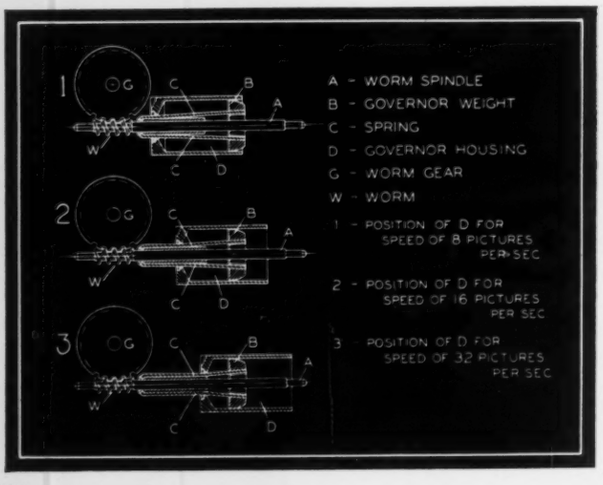


Fig. 1—Left—Design and action of the governor mechanism which keeps the speed of motor uniform throughout full operating period

Limiting and Governing Action

In the center of *Fig.* 2 can be seen a train of two gears. The upper one of these is fastened to the hub of the spring, the other is free to rotate when driven by the first. The numbers of teeth of these gears are unequal and are in such ratio that the shallow space provided between two teeth of the driver enmeshes with the two long teeth of the idler gear only after that number of revolutions which correspond to the predetermined effective unwinding of the spring. At the instant that the long teeth of the idler gear engage with this shallow space on the driver, the two gears lock each other, thus preventing any further unwinding of the spring.

The problem of maintaining a uniform unwinding of the spring for the duration of the film run was solved by adopting a high speed governor shown in working position at the left side of *Fig.* 2 and diagrammatically in *Fig.* 1. This device consists of a shaft of hardened and highly polished steel at one end of which a worm is cut to mesh perfectly with the

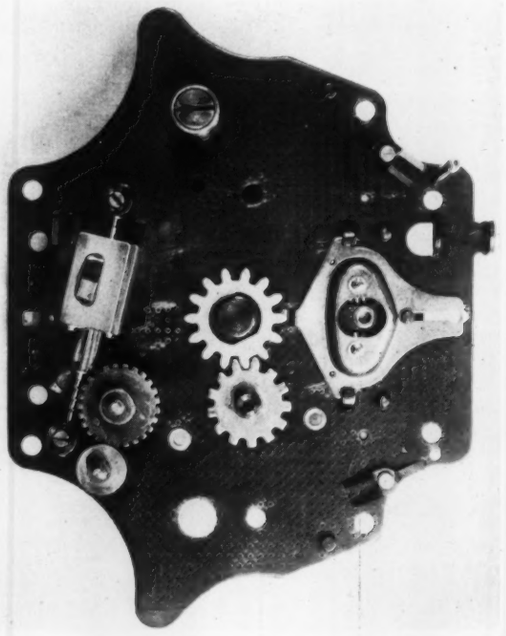


Fig. 2—Above—Gear train at center prevents unwinding of spring beyond the point of efficiency

teeth of a drive gear. A spring cut in the shape of a cross, with its four arms bent upward so that each functions as a separate spring, is securely fastened to the shaft. Four weights are solidly anchored at the free ends of the spring arms and this assembly is mounted on adjustable hardened steel bearings with double ball thrust.

How Governor Is Set

An outer housing free to slide along the spring is provided and a spring flexure control washer is mounted at the lower end of the housing but is left free to rotate with the worm shaft. Sliding of the outer housing is controlled by a graduated knob on the outside of the camera where it is readily accessible to the operator. The position of the governor housing, and therefore that of the flexure control washer, determines effective operating length of the governor.

When the worm shaft is caused to rotate by the energy released by the spring motor, centrifugal force throws the governor weights outward, thereby flexing the spring arms to which they are attached until the weights contact the inner wall of the housing. At this point the flexure of the springs is arrested and is maintained constant as long as the worm shaft is allowed to rotate, which at the most will be as long as the spring motor is allowed to expend its energy.

Springs vs. Centrifugal Force

The greater the operating length of the governor springs, the greater will be their ability to flex and therefore the lesser will be the effort necessary to bring their weight into contact with the inner wall of the governor housing. Vice versa, if the operating length of the governor springs is reduced, the effort necessary to flex them is increased.

Since the resistance offered by the springs to the influence exerted by centrifugal force upon the governor weights is overcome by the speed of rotation of the worm shaft, it is evident that the greater this resistance, i. e., the shorter the operative length of the springs, the higher will be the rotational speed of the shaft. It is also evident that the greater the speed of rotation of the worm shaft, the greater will be the centrifugal force acting on the governor weight and the more rapid will be the settling of the shaft at the desired speed.

In *Fig.* 2 there are illustrated three positions of the spring flexure control washer for three of the speeds of the Filmo camera, which range from 8 to 64 picture frames per second. It is worthy to note that the shaft of this governor rotates at a speed of 4000 revolutions per minute for a camera speed of 8 picture frames per second and at a speed of not less than 32,000 revolutions per minute for a camera speed of 64 picture frames per second. These extremely high velocities insure instantaneous action of the governor,

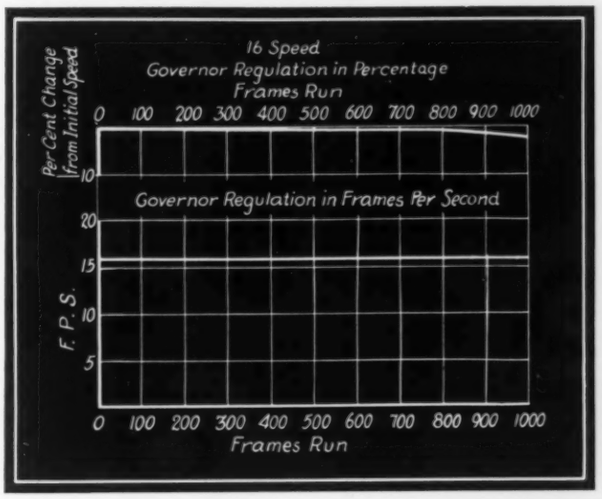


Fig. 3—Graphs showing actual test results of governor regulation both in frames run and percentages

with the result that the camera is made to operate at its full selected speed from the very first picture frame of each scene.

The curves in the graph, *Fig.* 3, show the governor regulations in both frames run and percentages, and prove the remarkable operating characteristics of this governor. Actually there is a variation of speed of only 2½ per cent over the full 25 feet of film run, which represents the capacity of the spring motor. These elements controlling the operating speed, together with other no less ingenious components, make this motion picture camera an instrument eminently suitable for serious industrial and scientific research as well as for the use by advanced amateurs who take up the making of motion pictures in a really thoughtful manner and who want an instrument which not only will perform unusually well under normal conditions but which also will effectively meet unusual conditions.

Results of Creative Engineering

A glance at the illustration which has been incorporated into the heading of this article will give an idea of some of the other things which creative engineering has accomplished toward making this camera not only an instrument of precision but also one of quick action, compactness and good looks. For instance, the turret idea—long in successful use on battleships and production lathes—has been adapted to the quick and accurate swinging into position of lenses of several different focal lengths.

Another point of particular interest to designers generally is the high degree of evolution which this camera represents beyond the bulky, boxlike forms of early designs. It serves as an effective example of what is made possible by designing for mechanical compactness, and use of such developments as die castings and modern finishes—all these things under the influence of modern industrial styling.

Scanning THE FIELD FOR Ideas

USE of V-belts for driving important units of its mechanism is an interesting feature of the all-crop harvester built by Allis-Chalmers Mfg. Co. The combination cut appearing herewith as *Fig.* 1 shows at the top a general view of the front and driving side of this machine while below is an enlargement of the system of V-belts.

The fan, screw conveyor and shaker are all driven by one belt. While these views do not show it, one of the belts is operated successfully in crossed or twisted position to give reverse driving, giving a very simple solution to that problem.

Being designed to handle a wide variety of crops ranging from bird seed to beans, means for adjustment must be provided in this harvester. In the case of speed adjustment to the units, this is taken care of by the use of adjustable sheaves. These are made with two saucer-shaped disks between which are rings or shims which can be added or removed to give the required spacing.

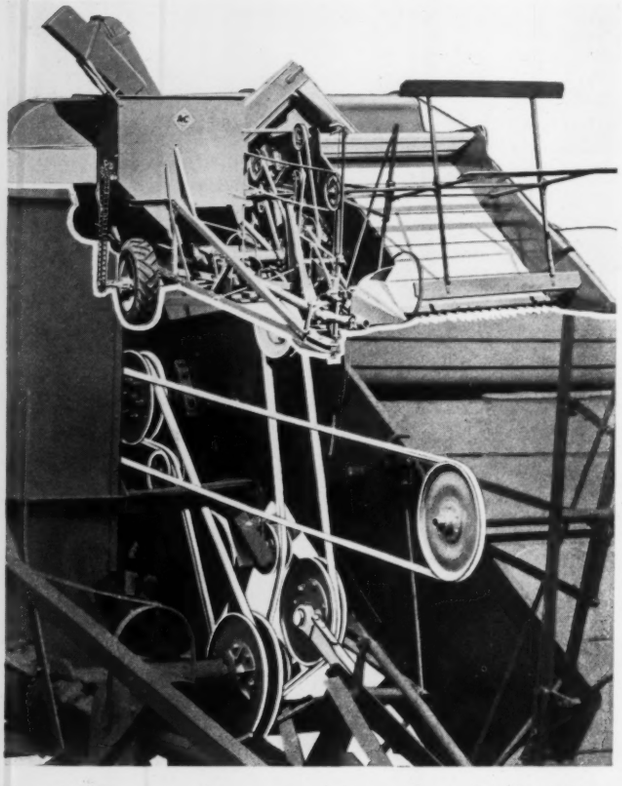


Fig. 1—Harvester for crops ranging from bird seed to beans uses V-belts to drive its auxiliaries

When these shims are removed the disks can be drawn closer together by their connecting bolts, thus running the belt on a larger diameter. One of these adjustable sheaves can be seen at the left center of the cut, partially hidden by the hopper casing.

Rubber Fingers Grade Potatoes

RUBBER rolls and spools play an important part in the motor-driven machine shown in *Fig.* 2, which has been developed by the John Bean Mfg. Co. for the accurate grading and cleaning of potatoes. Although it handles from 150 to 200 bushels per hour, segregating four different sizes, cutting and bruising is said to be entirely avoided.

In this machine, the unit at the left is a roller elevating conveyor which feeds the mixed potatoes into the central unit which is the most important one. This central unit has in the bottom of its trough a train consisting of: First, a pair of rubber rollers covered with short pliable fingers; second, three sets of rubber spools, also having pliable fingers; third, another roll; and fourth, three more sets of rubber spools.

A typical setting is, elimination of potatoes under 1-inch by the first set of rolls, which clean and feed forward the larger ones; separation of those under 1½ inches by the first set of spools; feeding and further cleaning action by the intermediate roll; and separation of those under 1⅞ by the final set of spools. Potatoes over 1⅞-inch then are discharged on to a third unit which is equipped with rubber feeding and cleaning rolls, which in turn deliver them to the turret-type bagging attachment at the right-hand end of the machine. Potatoes eliminated in the central unit drop down into chutes, all except the first of which have holders for burlap bags.

One of these sets of rubber spools is visible at the right-hand end of the central unit, and a rubber roller—identical to those used in the central unit—can be seen at the end of the third unit, just behind the bagging attachment. The spools revolve from 50

to 65 times per minute, presenting every potato to the round sizing openings many times and in every possible position.

Tool Is Tailored to Workmen

QUOTING Thomas Carlyle, technical writers often describe man as a tool-using animal. Designers, on the other hand, sometimes forget this—otherwise they would be more careful to tailor tools to fit men. It is an interesting fact that some of the most perfectly tailored tools are those which have attained their present form through evolution over a long period of time. Consider for instance the scythe, the axe, the handsaw, and—beyond the purely utilitarian—the gun stock, the violin and even the golf club.

Tools can be classified in two main groups; those to which the work is brought (a machine tool for instance) and those which are brought to the work (such as a portable drill or grinder). On the border line between these two lies a minor group having some characteristics of both groups. Of this a good example is the hydraulic spot welding gun shown in *Fig.* 3.

This tool, developed by the Progressive Welder Co., has been tailored to fit the operator as far as the lightweight working part or "gun" is concerned. Heavy parts are slung overhead to give the operator a wide range of free action. The unit is shown operating in an automobile body production line, the swivel-type overhead mounting giving working radius of 12 feet to the hand-guided "gun". The device mounted on the right-hand side of the transformer is a hydraulic booster by means of which a range of pressure from 0 to 3000 pounds is attained. Cables, as well as the transformer, are watercooled.

Squeezing action between the points is varied by fingertip control to suit the work and a simple hand-operated switch varies the output current to suit the welding conditions. After pressure and current are properly adjusted, all that is required to make a weld is to set the points in position and then press the operating button, duration of current flow being controlled by an automatic timing device.

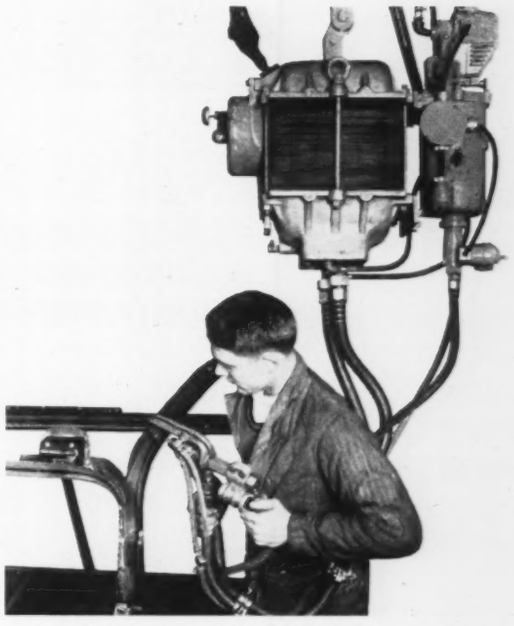


Fig. 3—Welder is designed to fit operator and all heavy parts are separately suspended

Brushes Traverse Commutator

DESIGNED for reliability and long electromechanical life, a new controller for electric industrial trucks developed by the Automatic Transportation Co. has several interesting design features.

As is apparent in *Fig.* 4, the mechanism has been condensed into a relatively small amount of space, but without crowding it or weakening it, or resorting to dangerously small clearances. To insure against slipping, serrated connections between shafts and arms are employed. One instance is at the hub of the speed

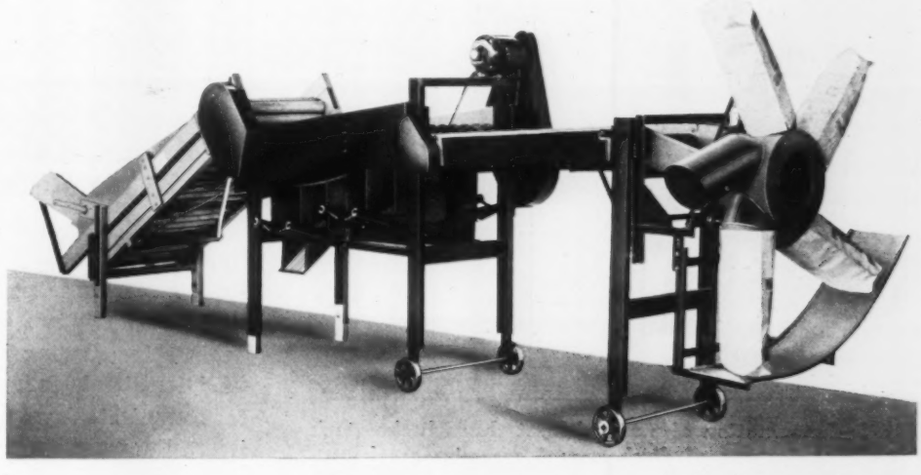


Fig. 2 — Potatoes are cleaned and graded in this machine by revolving rubber fingers which handle rapidly without bruising, giving positive separation of sizes

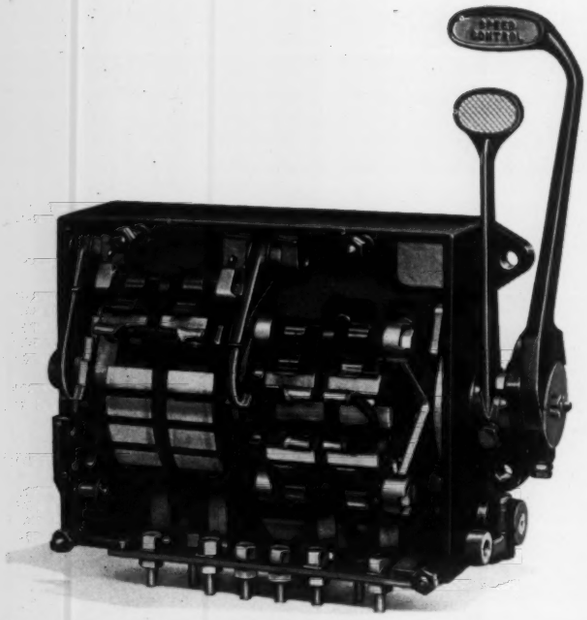


Fig. 4—Controller for electric industrial trucks operates by rotating the brushes around the commutator

control lever. This connection is visible at the right side of the case.

Instead of using a stationary finger and rolling the commutator, the commutator of this control is stationary and the brushes rotate around it. These brushes are of heavy motor type and the commutator is made up of wide copper segments molded into an insulating base. The controller gives four speeds forward and four reverse. In the illustration the reversing switch assembly can be seen at the right of the commutator.

Smoke is Self-Accusing

SMOKE control is a matter primarily of careful firing, but unless firemen are kept constantly informed of the condition of affairs inside the smokestack they cannot be certain as to how good a job they are doing. Not even visual observation of the top of the stack will tell the story at all times, especially at night.

The photoelectric cell presents a solution to this problem, in the simple manner depicted diagrammatically in *Fig.* 5. This shows the application of the photronic smoke alarm developed by the Weston Electrical Instrument Corp. A beam of light is projected through the stack so that normally it falls on a photoelectric cell in the light collector unit mounted at the opposite side of the stack. This cell passes electricity in proportion to the amount of light falling upon it.

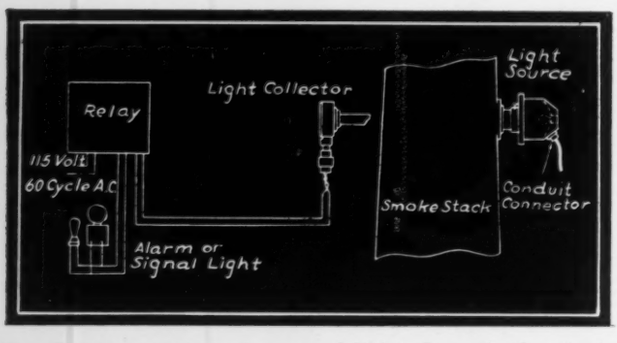


Fig. 5—Interruption of a ray of light through the stack warns firemen of discharge of excessive smoke

In the event that undue flow of smoke occurs, passage of light is hindered or even entirely cut off. Thereupon the cell—through a relay—causes a gong or signal light to go into action in the boiler room. When this happens the firemen immediately check up on their combustion instruments and readjust drafts and fuel supply to eliminate the excessive generation of smoke.

Fig. 6—This typewriter writes musical scores, even complicated symphonies, from normal four-bank keyboard

Musical Typewriter Helps Composers

A FOUR-bank typewriter for the rapid, legible writing of musical scores has been developed in Germany by Nototyp Rundstatler G.M.B.H. This machine, shown in *Fig.* 6, is neatly styled and designed for volume production.

With a normal (forty-seven key) keyboard and simple shift, the machine writes all note values from whole notes to sixty-fourth notes and chords, also key signatures, volume indicators and time indicators. It will produce two sizes of scores, a large size convenient for reading by students which commonly is used for simple folk music, and a small size suitable for complicated symphonic works which demand maximum lines per page.

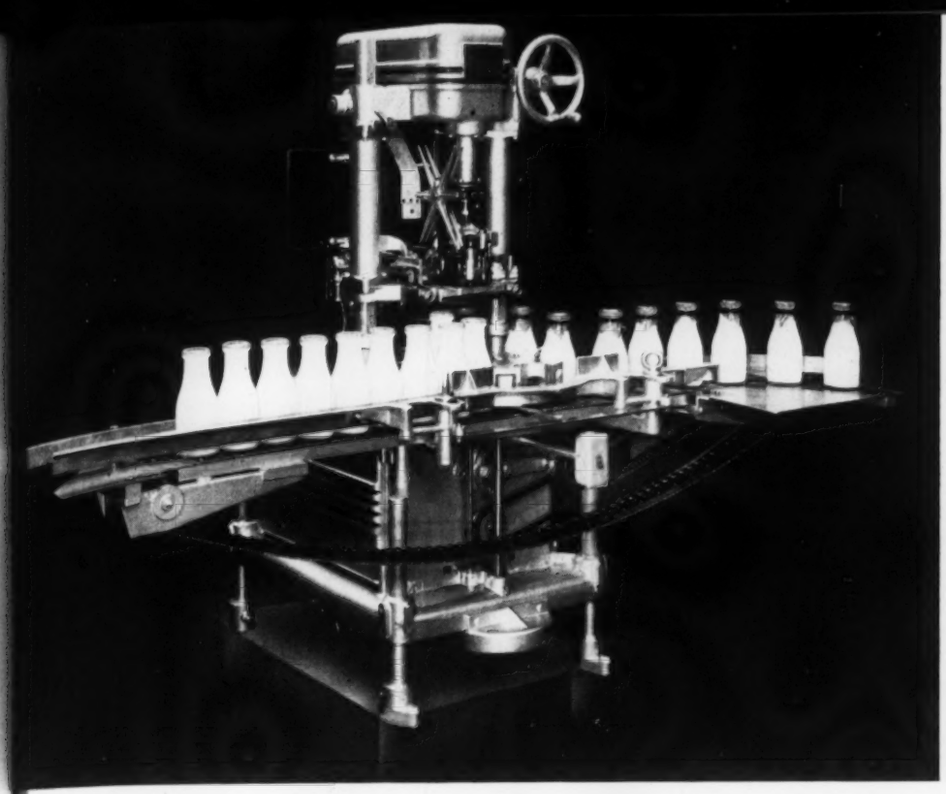


Fig. 1—Electric heat is used in this automatic milk bottle hooding machine for sealing together the thermo-plastic tape which retains the cellophane hoods

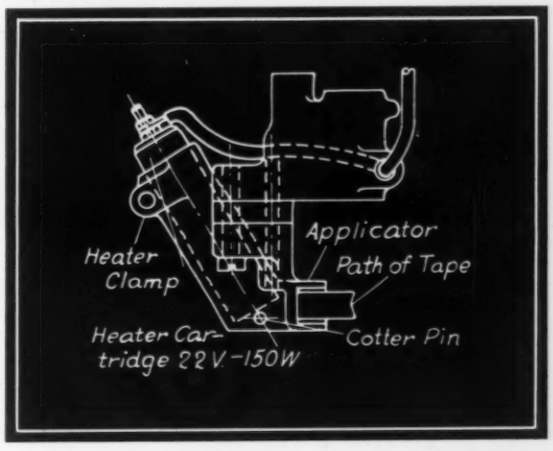
Machinery Heating Problems Can Be Solved Electrically

By Guy Hubbard

APPLICATION of heat is essential at some particular point in a great many manufacturing processes. In the past numerous production cycles which otherwise were successfully mechanized even to the extent of being automatic, left the operation involving the use of heat to be a secondary one. Not only might the heat application be secondary, but in not a few cases it was carried out in a primitive way by hand. Today can machines for instance are not only marvels of speed but also of complete automaticity. In the earlier days of their development, however, some of the most ingenious ones demanded the more or less constant attention of a tinsmith armed with an old fashioned soldering copper to make up for the shortcomings of their mechanical soldering apparatus. Comparable situations existed in the early days of bread wrapping and other packaging machines, shoe machinery, etc., which involved the use of paraffin and other waxes.

Many of the early difficulties were due to the fact that means for attaining a high degree of clean, flameless "spot heat" were not available. Today this requirement in almost every case has been taken care of by various forms of electric heating

Fig. 2—Method of mounting the cartridge heating unit in the tape applicator of the bottle hooding machine. Only one lead is used, return being through the frame



units. These have been developed by a number of manufacturers to the point where they are not only compact, reasonable in price and easy to apply, but also are dependable and long lived. The range of types, sizes, shapes and capacities is so large that with the help of the engineers of the companies manufacturing the units the machine designer in most cases can find standard models and standard control equipment to fit his particular needs. In any event the electrical manufacturers can make up units which will do the work, even though it is of unusual character.

Beware of Bending

At this point let us inject a word of caution regarding any attempts on the part of a machine builder to alter standard units. It is, for instance, a great temptation to bend or twist metal covered plate and strip heaters to fit—let us say—a curved chute. Nine times out of ten such treatment will fracture the insulation and if it does not immediately ruin the heater it will lead to its early breakdown in service. Close contact between the heater and the surface to be heated is essential but when a curved surface is involved, have the electrical manufacturer make up a properly curved unit for you. Don't try to "roll your own"!

Another thing to think about in applying electrical heat to machinery is how to keep the heat from wandering away from the spot or area where it is wanted. Heat travels rapidly and surprisingly far through continuous metal — especially if it be copper, brass or aluminum. It can do a lot of damage if it gets to bearings in the machine or to parts of the product that should not be heated. The designer therefore should give careful attention to the localization of the heat by airgaps, insulation, ventilation, water cooling, etc. Inserts of heat resisting plastics often can be used to cut off the unwanted flow of heat, along the line of the heat insulated coffee pot handle.

The variety of heating units is so wide and the manner in which they can be applied in machinery is so varied, that it is impossible to cover the subject comprehensively in an article of this length. Under these circumstances the logical thing to do is to inspire designers to give attention to the possibilities of electric heat by telling briefly of the successful achievements of fellow designers who already have delved into this field.

First let us us consider the milk bottle hooding machine illustrated by *Fig.* 1 at the heading of this article. Of this recent development by the Package Machinery Co., E. Lovell Smith, chief engineer, gives the following details: "This fully automatic machine cuts off a square piece of cellophane, through which the top of the bottle is thrust upward into a rotating head. On this head are mounted devices for feeding and cutting the sealing tape which is coated on one side with a thermoplastic adhesive.

"Also incorporated in this head are fingers for pressing this tape against the neck of the bottle and a heater mounted on a hinged arm. This is spring-pressed against the revolving bottle neck and seals the binding tape both to the cellophane hood and to itself—there being a lapover in the tape of about 1 inch. We had to get a 150 watt cartridge heater into this hinged arm, the arm itself being mounted on a rotating head.

"The diagram, *Fig.* 2, gives some idea as to how the heating element has been applied. Because of space limitations and to save complications in the wiring, note that we use only one lead to the heater. The other terminal of the cartridge is grounded and the machine itself is used for a return. The 150 watt input is quite large for so small a heating unit. Therefore to prevent overheating when the machine is stopped we have provided a separate segment in the heating current collector ring at the place where the machine stops. When the brush rests on this segment an extra resistance is cut in which cuts down the input to a point where radiation and conduction prevent undue temperature rise. Incidentally, the collector ring is stationary and the brush revolves around it as the machine operates.

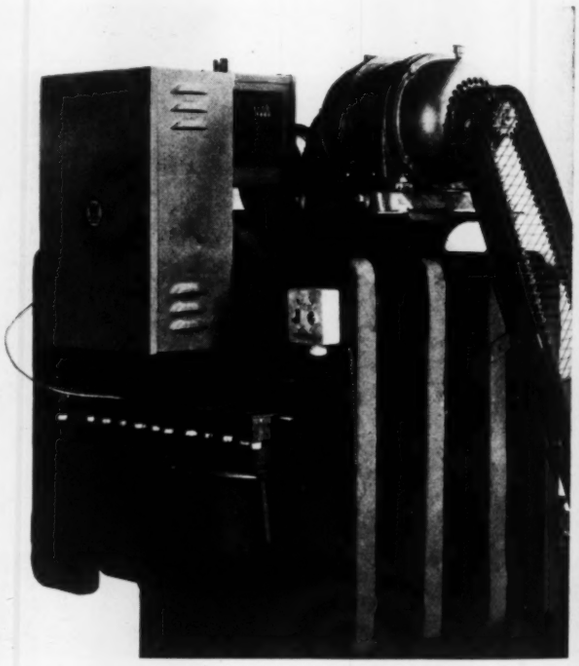


Fig. 3—Twelve embedded strip units heat the plate on the lower platen of this 800-ton matrix press

"The machine is equipped with a variable speed drive which enables the operator to adjust the speed of the hooding operation to handle from approximately fifteen to forty bottles per minute."

In operations where a combination of both pres-

sure and heat must be employed to form and at the same time to set plastic materials electric heating elements often can be used to advantage. A case in point is the 800 ton matrix press built by the Ostrander Seymour Co., of which a rear view is shown herewith as *Fig.* 3. The lower platen of this press carries a ground pressure plate in which are embedded twelve Westinghouse metal clad strip heaters. This arrangement gives efficient heat transfer together with effective protection of the heater units.

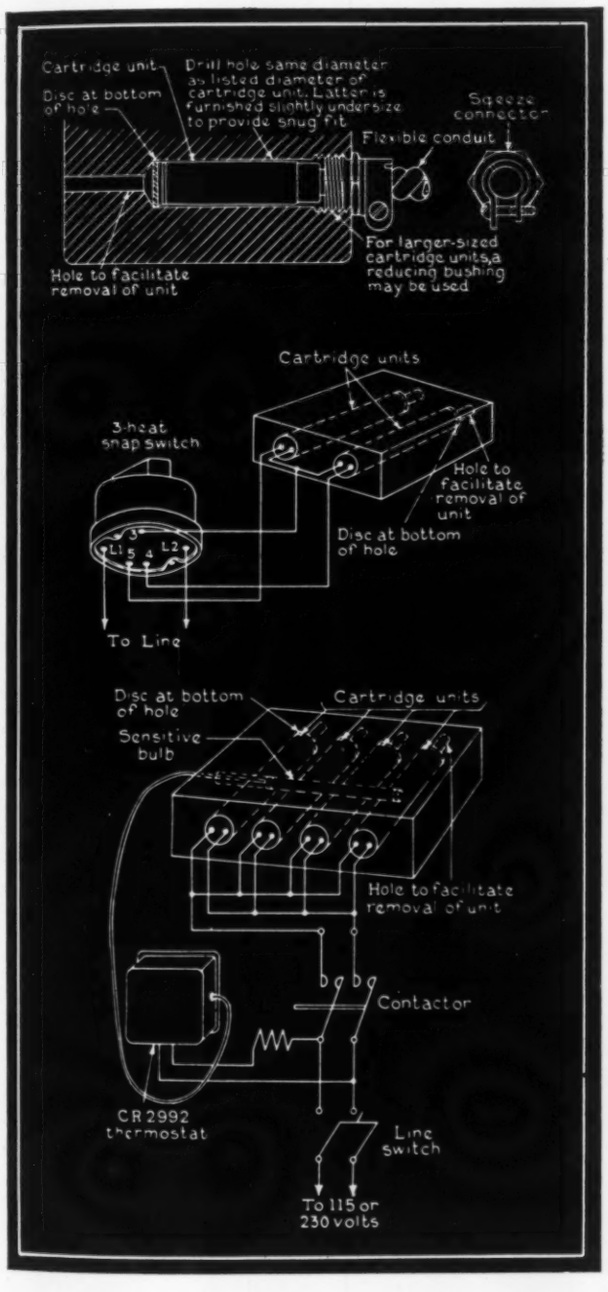

Cartridge unit
Disc at bottom of hole
Drill hole same diameter as listed diameter of cartridge unit. Latter is furnished slightly undersize to provide snug fit
Squeeze connector
Flexible conduit
For larger-sized cartridge units, a reducing bushing may be used
Hole to facilitate removal of unit
Cartridge units
3-heat snap switch
Hole to facilitate removal of unit
Disc at bottom of hole
L1 5 4 L2
To Line
Disc at bottom of hole
Cartridge units
Sensitive bulb
Hole to facilitate removal of unit
Contactor
CR 2992 thermostat
Line switch
To 115 or 230 volts

Fig. 4—Recommended systems of installing and wiring standard cartridge heating units. Drawing at the top shows how provision should be made in the mounting for possible removal of the unit. Diagram at center is of a simple three-heat connection for a two-unit installation. Bottom diagram depicts the application of automatic control through use of thermostat

Another somewhat similar case which involves rollers instead of platens is a high speed embossing machine for making fillers for egg crates. In this machine moistened paper board is passed through a set of four rolls which form cups in the paper to fit the ends of the eggs and also dry out the moisture so that the formed cups will retain their shape. This requires that a temperature of 400 degrees Fahr. be maintained by each of the rolls.

With the co-operation of engineers of the Edwin L. Weigand Co. this result was attained by placing in the interior of each roll a longitudinally slotted metal core, into the slots of which were fitted Chromolox strip heaters of curved cross-section to comform to the bore of the outer shell. These rolls are what might be called "awkward" size, in that they are too large for practical heating by cartridge units, yet not large enough to permit the usual method of clamping strip heaters directly against the inside of the roll. Hence this rather unusual solution of the problem.

Cartridge heaters can be designed to operate at sheath temperatures ranging from 750 to 1200 degrees Fahr. and the best results are as a rule obtained when the clearance between the heater sheath and the part into which they are set does not exceed 0.010-inch. When mounted in a die, even distribution of heat can be obtained by using high voltage heaters at the outside edges and smaller heaters in the center.

Suggestions on Installation

The General Electric Co. has made some pertinent suggestions as to the simple and effective installation of cartridge units. These suggestions are illustrated in diagrammatic form by means of the three drawings reproduced herewith in *Fig.* 4. It is pointed out that it is necessary only to provide a hole in the part to be heated, of a diameter equal to the listed diameter of the cartridge unit to be inserted—which is slightly under size.

As indicated by the top view in the set of drawings, it is advisable wherever possible to extend a small diameter continuation of the hole entirely through the part so that the unit readily can be driven out should necessity for its removal ever arise. Even though it may be a light push fit when originally inserted, a cartridge unit will expand in use until it becomes an extremely tight fit in its hole. While this characteristic is highly advantageous from the standpoint of efficient thermal conductivity, it does make the unit difficult to remove unless means for driving it out is provided in the design of the mounting.

The middle view shows a simple method of making a three-heat connection on a two-unit installation. The bottom view depicts an effective application of automatic temperature control.

Operating Factors Influence Gear Design

By J. O. Almen
Head, Dynamics Department, General Motors Corp.

ACCURATE means of determining tooth stress is more important to the automobile gear designer than to the designer of industrial gears. Consideration of cost, weight and space demand that automobile gears be reduced to the smallest possible size consistent with satisfactory service.

It is impossible to compute by rigorous mathematics the actual bending stresses in gear teeth because of the many indeterminate variables that are involved. The usual gear formulas assume that the gears are accurately cut and mounted and that the gear material and the supporting structure is inflexible. Not only are these assumptions not realized in practice, but other factors are invariably present that localize stresses in an unpredictable manner.

IT is not enough in gear design to figure on a conventional factor of safety, to use the best material, and cut the gear accurately. Conditions under which the gear will operate must be studied and the subsequent design based on this study. The accompanying article includes two papers given at the annual meeting of the American Gear Manufacturers' Association which bring out operating factors to be considered

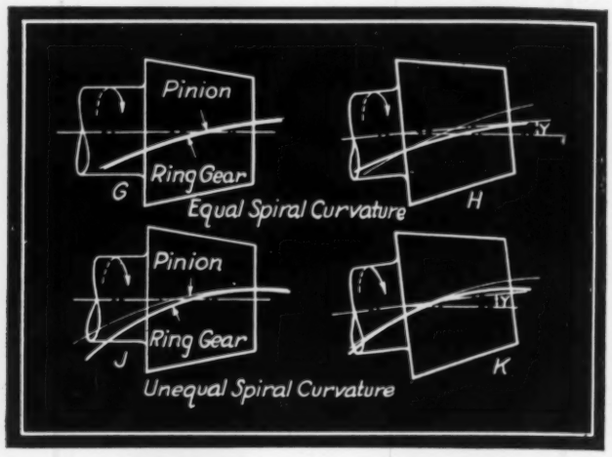


Fig. 1—Sketches show drastic load concentration if perfect contact is attempted, contrasted with method used in practice to avoid concentration

Automobile gear service differs from industrial service in that the total time of operation at maximum load is relatively short. It is, therefore, not necessary that automobile gears be designed to run at maximum load to the fatigue endurance limit. As in rear axle gears, the minimum life for the pair of gears used in low speed need not exceed 100,000 cycles at maximum engine torque to be free from breakage trouble during the entire life of the car. Gears that are used in second gear require somewhat greater life, approximately 300,000 cycles, since the accumulated operation in second gear at maximum load during the lifetime of the car is greater than for low gear ratio. Two other gears are in use during the accumulated time of low gear operation as well as the accumulated time in

TABLE I

Service Factors for Helical and Herringbone Speed Reducers

Character of Load on Driven Machine	Electric Motor or Turbine			Multi - Cylinder Oil, Gas, or Steam Engine			Single Cylinder Oil, Gas, or Steam Engine		
	Intermittent 3 Hours Per Day	8 - 10 Hours Per Day	24 Hours Per Day	Intermittent 3 Hours Per Day	8 - 10 Hours Per Day	24 Hours Per Day	Intermittent 3 Hours Per Day	8 - 10 Hours Per Day	24 Hours Per Day
Uniform	.8	1.0	1.25	1.0	1.25	1.5	1.25	1.5	1.75
Moderate Shock	1.0	1.25	1.5	1.25	1.5	1.75	1.5	1.75	2.0
Heavy Shock	1.5	1.75	2.0	1.75	2.0	2.25	2.0	2.25	2.5

TABLE II

TYPICAL SPEED REDUCER APPLICATIONS GROUPED TO INDICATE NORMAL CHARACTER OF LOAD

UNIFORM LOAD:-

Agitators
- Liquid
- Semi-Liquid

Bottling Machines

Bleachers

Blowers
- Centrifugal or Vane

Conveyors
- (Uniformly loaded or fed)
- Apron
- Assembly
- Belt
- Oven
- Screw

Cookers
- Cereal

Can Filling Machines

Elevators, Bucket
- (Uniformly loaded or fed)
- Centrifugal discharge
- Gravity discharge
- Continuous bucket

Fans (Uniform Speed and Balance)
- Light
- Centrifugal
- Propeller

Feeders
- Disc Type

Generators

Kettles
- Brew

Line Shafts
- Light

Machine Tools
- Light

Mash Tubs

Mixers
- Liquid
- Semi-liquid

Pumps
- Centrifugal
- Geared
- Rotary

Screens
- Air Washing
- Traveling water, intake

Textile Machinery
- Cards

MODERATE SHOCK LOAD:-

Beaters
- Pulp

Blowers
- Lobe

Car Pullers

Compressors
- Centrifugal or Rotary
- Reciprocating (3 or more cylinders)

Conveyors
- (Heavy duty or dual drive, rough and non-uniform material)
- Apron
- Belt
- Live roll
- Screw

Draw Bench

Dryers
- Rotary

Elevators
- Heavy duty bucket
- Freight

Fans
- Large mine
- Induced draft

Feeders (Pulsating Loads
- Apron
- Belt
- Screw

Hoists
- Reversing
- Skip

Kilns
- Cement
- Lime

Mills
- Ball
- Pebble
- Rubber Sheet

Mixers
- Dough

Pumps
- Reciprocating (3 or more cylinders)

Screens
- Rotary, gravel or stone

Stock Chests

Stokers

Textile Machinery
- Looms

Wire Drawing Machines
- (Individual)

HEAVY SHOCK LOAD:-

Compressors
- Reciprocating (Single or two cylinder)

Conveyors
- Reciprocating
- Shaker

Crushers
- Ore
- Stone

Dredge Cutter Head

Feeders
- Reciprocating

Hoists - Mine

Jordans

Mills
- Hammer
- Rod
- Rubber Calender

Pumps
- Reciprocating (single or two cylinder)

Punch Presses

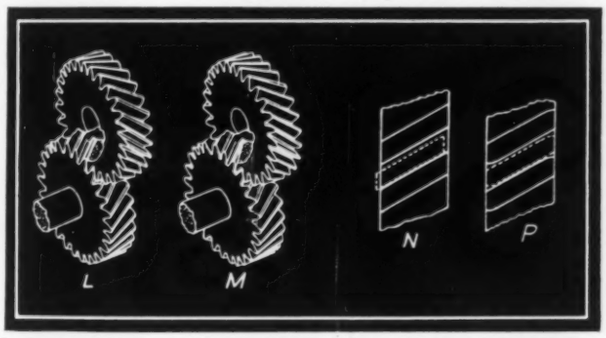


Fig. 2—Helix angle errors produce concentrated load in teeth, left. Two methods of avoiding stress on weak end of tooth are shown at right

second gear and, therefore, the minimum life for this pair should be the sum of the other two sets or 400,000 cycles. It should be understood that the above limits are minimum values and that as a safety factor the average durability should be at least twice as great since a variation in life of 200 per cent to 300 per cent in presumably identical gears may be expected.

The large difference in life of helical transmission gears is the result of small variations in the contacts between mating teeth. Ideal contact conditions in which the load is distributed over the face of the teeth as is promised by the layout and hoped for by the designer is approached only by rare accident. If it is assumed that the teeth can be made to mate perfectly, as may be approached by careful lapping, the perfection is destroyed as soon as the load is changed. When load is applied to the gears the teeth are deformed, the shafts bend, the case deflects, clearances are taken up and the fancied perfection is impossible except under single load conditions. A clearer conception of the deformations that occur can be had by imagining all parts of the transmission to be made of rubber. With such a transmission before him, the designer would have a much better appreciation of his problem.

The more uniform durability of spiral bevel gears is not accidental but is inherent in the design of the gears. In spiral bevel gears the impossibility of attaining ideal contacts is recognized and the teeth are deliberately cut to mismate in order to avoid the greater contact error that would result if the ideal contact were attempted. *Fig.* 1 shows four exaggerated sketches of mating teeth of a spiral bevel pair. Sketch *G* illustrates an ideal mating, the teeth resembling the type of contact sought for in spur and helical gears. Sketch *H* illustrates the contact conditions as they would be under increased load. The deflections of the pinion shaft and supporting bearings are such as to concentrate the load at the large end of the teeth, the result being highly concentrated stress and early failure. Sketch *J* illustrates the contact in spiral bevel gears as actually cut. The radius of curvature of the pinion tooth is greater than the radius of curvature of the gear tooth by an amount sufficient to permit the deflections illustrated in *K* without the severe concentration of load at the large ends of the teeth as illustrated in *H*. This rocking chair principle not only increases the resistance to fatigue by reducing stress concentrations but also is necessary to avoid gear noise.

In contrast to spiral bevel-gear practice, spur and helical gears are cut to mate in the manner illustrated

in *G* and in consequence actually mate as illustrated in *H* due not only to deflections but also to unavoidable errors in helix angle as a result of warpage, manufacturing tolerances, and other factors.

Throughout the fatigue tests of helical transmission gears, it has been observed that in a pair of identical mating gears the gear that will break depends upon which ends of the teeth are most heavily loaded. This is as would be expected from the shape of the teeth as shown in *Fig.* 2 in which *L* and *M* illustrate identical pairs of gears except for the direction of helix angle error. Assuming in each case that the upper gear drives in a clockwise direction, the helix angle error in *L* is such as to concentrate the load on the left-hand end of the teeth and in *M* the helix angle error causes concentration of load on the right-hand

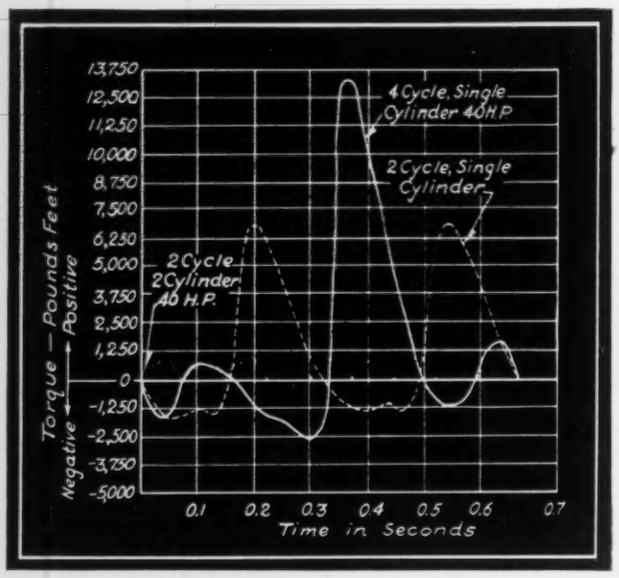


Fig. 3—Variations in torque from one and two-cylinder engines cause sudden loads on gear teeth

end of the teeth. For the mating error shown in *L* the lower gear will break and for the mating error shown in *M* the upper gear will break. This is because the tooth flank forms an acute angle with the tooth end, and the load, which is normal to the tooth, is applied on an over-hung portion of the tooth. The mating tooth carries its load adjacent to the obtuse-angled end and is, therefore, stronger. This order of failure will hold for either direction of rotation and for either direction of load.

If the contact error is always on one end of the teeth, partial compensation is possible by increasing the thickness of the disadvantageously loaded tooth and correspondingly decreasing the thickness of the advantageously loaded teeth. This expedient is resorted to in automobile spiral bevel gears and results in a large increase in life for forward drive, but since in such gears the contact concentration is on the same end of the teeth for forward and reverse drive, the ring-gear life is reduced when driven in reverse. This is permissible, however, since the life requirements for reverse drive are less than for forward drive. The advantage of this compensation in spiral bevel gears is often confused by four-square test fixtures in which gears are loaded in both forward and reverse. In such tests it is usually found that the pinion of the gears that are driven forward will fail but that earlier failure will occur in the ring for the gears run in reverse.

Another method of avoiding stress concentration on the acute-angled end of helical gear teeth is shown in *Fig.* 2, *N*. The mating gears are displaced in an axial direction an amount sufficient to prevent contact on the overhung portion of the teeth. This method is useful only for one direction of drive. If the acute-angled ends of the teeth of both gears are relieved, as shown in *Fig.* 2, *P*, the resistance to breakage is increased for either direction of drive and for load concentration at either end of the teeth. This is an approach to cutting the gears for large helix angle tolerance, as practiced in rear axle gears, and will result in greater durability than the method shown in *Fig.* 2, N.

Type of Service Is Given Special Consideration

By S. L. Crawshaw

Nuttall Works, Westinghouse Electric & Mfg. Co.

IN THE design of gearing for parallel shaft operation, the main problem is purely geometric. It is simply a question of arriving at tooth forms which will result in a uniform angular velocity ratio. In the applying of such gear trains to perform useful work, the problem becomes more involved because of many influencing factors arising from the mounting, method of loading, lubrication and other variables. The result is that "application factors" are sooner or later adopted for each typical drive as a result of experience —most of them being based on empirical data rather than the result of an analytical study.

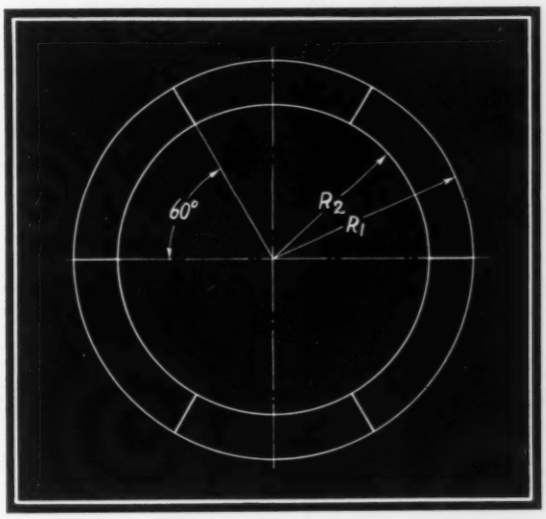
This term, "application factors" is used to designate a correlation of service factors with conditions normally existing in a given drive to which a speed reducer is to be applied.

A group of service factors is shown in Table I. Just as some arbitrary basis must be used in arriving at allowable unit stresses on which catalog ratings are computed, likewise provision must be made for the variable factors of time, load, and prime mover as shown in the table.

In the classifying of a specific application under the proper service factor, the first consideration is character of the load. In the interest of simplicity, only three classifications have been listed—uniform, moderate shock, and heavy shock. Obviously, as a result, the range of each class is quite broad and the listing of specific applications becomes more or less a matter

(*Continued on Page* 89)

Fig. 1—Considerable material may be saved by cutting segments of this type if formulas are applied to laying out stock



Economy Gained by Stock Layout Formulas

By Joseph Waitkus

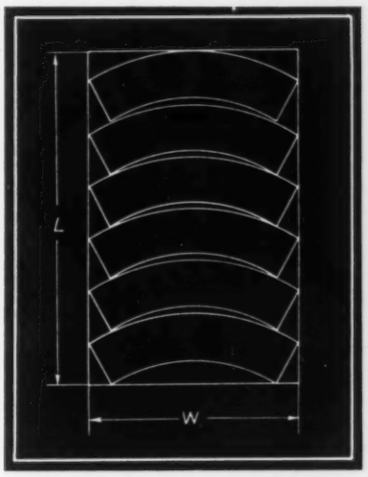


Fig. 2—Length and width must be calculated for obtaining good stock economy

TRIAL and error methods of ascertaining correct dimensions are a tedious process. Though final results may be accurate, valuable time is spent in guessing and the solution of every subsequent layout is an entire problem within itself. Alert engineers make every effort to use formulas or equations for design problems that are encountered often. Not only are results mathematically accurate, but the designer has the satisfaction of knowing he has solved his problem in the most workmanlike manner.

In the fabrication of large rings of thick, steel plates it has been desirable to utilize formulas prior to the welding of a series of segments as shown in *Fig.* 1. Six segments, each equivalent to 60 degrees of the arc of the plate, are cut with an acetylene torch. *Fig.* 2 illustrates the method of cutting the segments to obtain good economy with a minimum of waste stock.

The dimensions of different rings vary widely, requiring a good deal of calculation to determine the size of the plate from which to cut the segments. Following is a method of deriving a simple equation in which the substitution of numbers representing the inner and outer radii of the finished piece will give the desired dimensions of the segment stock from which they are to be cut. Two segments are shown in an enlarged view in *Fig.* 3 with letters indicating the important points used in the derivation of the equation.

These calculations are divided into four stages: First, the determination of the clearance space X between two successive segments. Second, the amount of material necessary for one complete segment. Third, the equation for determining the material necessary for six segments, and finally, an equation suitable for any number of segments. This fourth equation is given as an aid to those wishing to cut more than six segments from one plate.

The standard equation for determining the depth of a segment is:

$$H = R - \frac{1}{2}\sqrt{4R^2 - a^2}$$

where R = radius of the arc and a = length of the chord.

Referring to *Fig.* 3 we apply this equation to de-

termine the depth of the arc made by radii R_1 and R_2 between the points A and B. Two equations are thus obtained and subtracting one from the other we get the expression:

$$H_1 - H_2 = X = \left(R_2 - \frac{1}{2}\sqrt{4R_2^2 - C^2}\right) - \left(R_1 - \frac{1}{2}\sqrt{4R_1^2 - C^2}\right)$$

But $C = R_2$ because the arc and chord span an angle of 60 degrees and the chord is, therefore, one

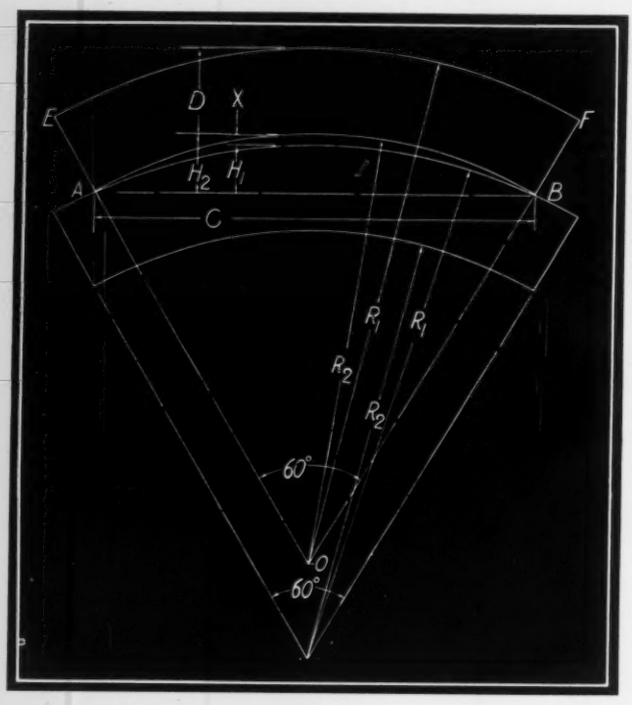


Fig. 3—Two circular segments are used for basis of equation derivation

side of the equilateral triangle AOB. Substituting in the above, we obtain the expression:

$$X = \left(R_2 - \frac{1}{2}\sqrt{4R_2^2 - R_2^2}\right) - \left(R_1 - \frac{1}{2}\sqrt{4R_1^2 - R_2^2}\right)$$

$$X = \left(R_2 - \frac{1.732\ R_2}{2}\right) - R_1 + \frac{1}{2}\sqrt{4R_1^2 - R_2^2}$$

$$X = 0.134\ R_2 - R_1 + \frac{1}{2}\sqrt{4R_1^2 - R_2^2} \quad \ldots\ldots\ldots (1)$$

For determining the material necessary for one complete segment we derive the following equation from the diagram shown in *Fig.* 3.

$$D + H_2 = D + \left(R_2 - \frac{1}{2}\sqrt{4R_2^2 - R_2^2}\right)$$

Substituting R_2 for C

$$D + H_2 = D + \left(R_2 - \frac{1}{2}\sqrt{4R_2^2 - R_2^2}\right)$$

$$D + H_2 = D + R_2 - 0.866\ R_2$$

But we note that $D = R_1 - R_2$
Substituting again, we get

$$D + H_2 = R_1 - 0.866\ R_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Combining the two equations we have derived, we can now obtain an equation for determining the length of material for six segments.

$$L = 5D + 5\left(0.134\ R_2 - R_1 + \frac{1}{2}\sqrt{4R_1^2 - R_2^2}\right) + R_1 - 0.866\ R_2$$

$$L = R_1 - 5.196\ R_2 + \frac{5}{2}\sqrt{4R_1^2 - R_2^2} \quad \ldots\ldots\ldots\ldots (3)$$

Equation (3) can be arranged in the following manner to give the length of material necessary for any desired number of segments.

Let S equal the number of segments. Then

$$L = S \times D + S\left(0.134\ R_2 - R_1 + \frac{1}{2}\sqrt{4R_1^2 - R_2^2}\right) + (R_1 + 0.866\ R_2)$$

which reduces to

$$L = R_1 + 0.866\ R_2\ (S + 1) + \frac{S}{2}\sqrt{4R_1^2 - R_2^2} \quad \ldots\ldots (4)$$

The above equations deal principally with the length of the plate required. The width of the plate is obviously very easily determined by the fact that it is equal to the radius R_1 of the ring, because for an angle of 60 degrees the chord spanning the distance between E to F is part of the equilateral triangle EOF.

In actual practice it is desirable to provide ¼ inch extra in length for each segment being cut from the plate. This additional stock is necessary to provide for the width of the torch cut as points A and B. However, the clearance is optional and will vary, depending upon the application of the method.

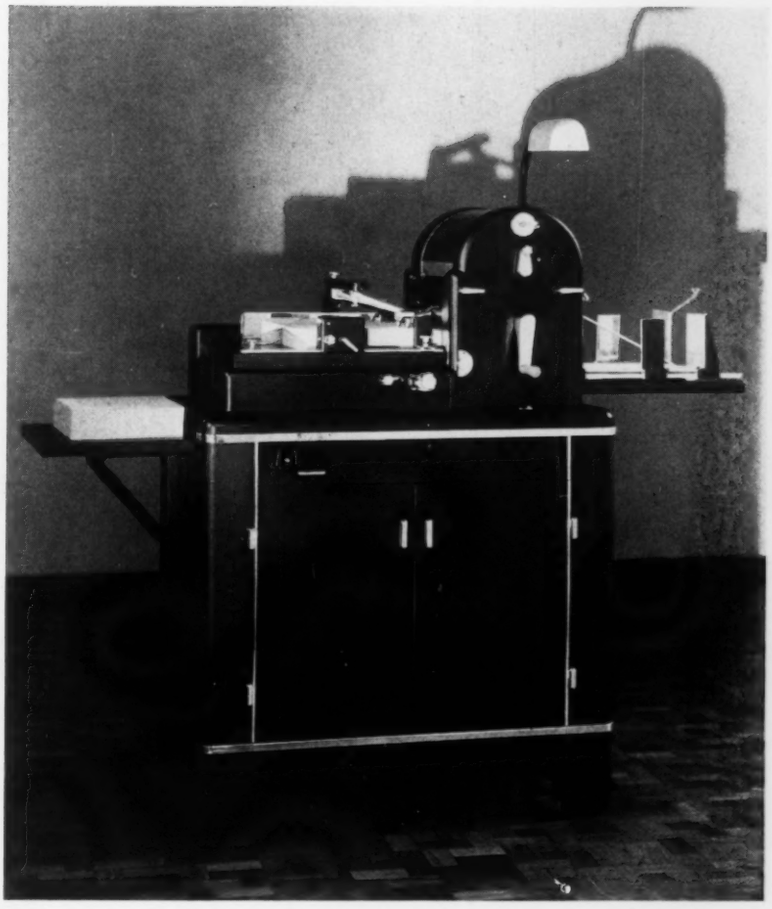
Meetings

July 21-23—
American Society of Civil Engineers. Annual convention to be held in Detroit. George T. Seabury, 33 West Thirty-ninth street, New York, is secretary.

Aug. 30-Sept. 3—
National Association of Power Engineers. Annual meeting to be held at Jefferson hotel, St. Louis. F. W. Raven, 196 West Adams street, Chicago, is national secretary.

Aug. 31-Sept. 3—
American Institute of Electrical Engineers. Pacific coast convention to be held in Spokane, Wash. H. H. Henline, 33 West Thirty-ninth street, New York, is secretary.

+ Refinements =



APPLYING modern design to the old, cumbersome mimeograph has produced an attractive, easily controlled machine that readily lends itself to office surroundings. The new mimeograph, styled by Walter Dorwin Teague, through the adoption of refinements possible by building-in parts, departs entirely from the forbidding and unfinished appearance of the former model. Noteworthy mechanical improvements add to its excellence.

In the past some designers have felt that there was little need for styling industrial machines or those used for purely utilitarian purposes. Sales experience shows, however, that the machine with individuality in appearance as well as in mechanical features catches the fancy of the discriminating customer.

Simplified operation in the improved mimeograph is achieved by placing controls within natural range of the operator's hands. Lubrication by a central oiling system insures adequate oiling and helps clean up the machine. Enclosed in the stamped-steel base is the motor and driving mechanism, easily accessible for inspection or repairs, yet hidden from view. Weight has been reduced with die-cast aluminum frames, without sacrificing strength or stability. Finished in harmonizing colors, this machine signifies as well as any the modern trend of machine design.

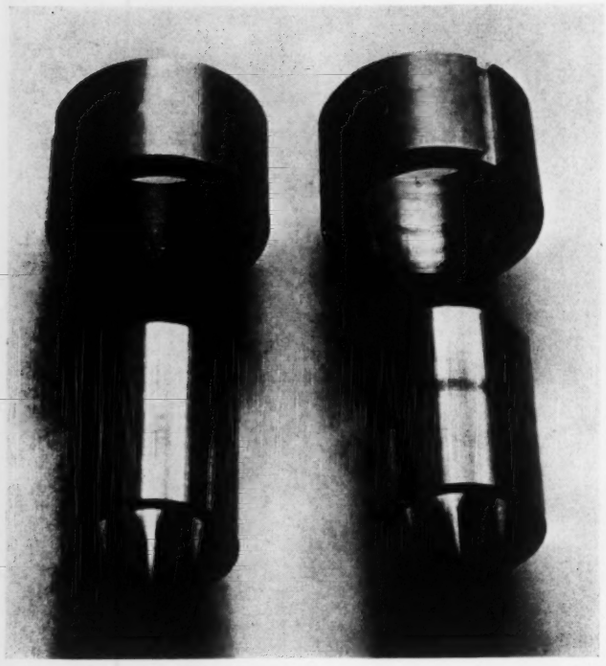


Fig. 1—Shaft on right which ran dry in metal bushing was scored. The other, turning in plastic bearing, was not marred

Oilless Bushings Reduce Machine Maintenance

By Fred Kelly

GREATER machine use in homes and offices by persons unfamiliar with mechanical operations is partly responsible for an increasing use of oilless or self-lubricating types of bearings. Too, the development of complex machines in which certain bearings are not easily accessible for lubrication or where conditions will not permit the use of oil or grease as a lubricating medium calls for special bearing materials. Designers are realizing that earnest attempts on the part of machine builders to inculcate buyers with the necessity for periodic lubrication have proved unsuccessful in many instances and that it is now up to them to specify bearings that do not require oil or grease for long periods.

Household appliances such as washing machines, vacuum cleaners, and kitchen aids are now equipped with oilless bushings. The average housewife seldom bothers with systematic oiling of her machines and any failure from this cause would be apt to reflect on the mechanical fitness of the product. Children's toys often receive exceptionally hard usage, but little care. One velocipede manufacturer equips his product with self-lubricating bushings, thus reducing wear of wheel bushings considerably.

The use of wood bearings is probably as old as the first machine. Early farm machinery as well as modern models utilize oilless bearings extensively. Natural resins in the wood provide lubrication for moving parts and after being impregnated with oil their ability to withstand long usage is remarkable. Thirty years ago wood bearings were the most popular type of oilless bearing. Textile machines in which it is important that no oil or grease be thrown from the bearings, employed them with success. In addition to being self-lubricating, wood bushings are often employed to reduce noise, being much quieter than a metallic composition. The principal objection to this type of oilless bearing is the need for a shaft clearance two or three times that required by a metallic bushing. Inasmuch as moisture or dampness will cause a wood bearing to swell, a shaft must be fitted with plenty of clearance. Careful selection of the impregnating compound will control swelling of the wood to some degree. Certain woods are hygroscopic themselves, attracting moisture from the atmosphere and therefore not suited as a bearing material. For various operating conditions

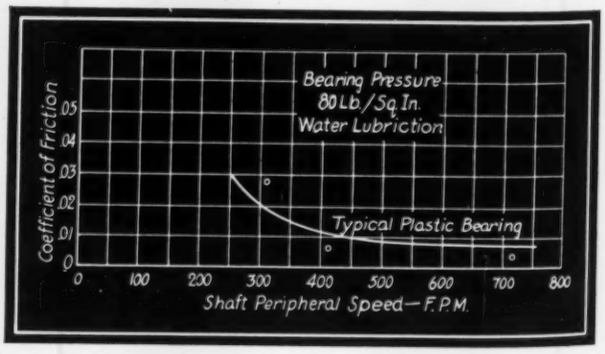


Fig. 2—Coefficient of friction becomes less as rubbing speed increases with water lubricated plastic bearing

different impregnating oils are used.

A wood bearing can only be specified, of course, where the loads are light and shaft speed low. As long as little heat is built up in the bearing, an impregnated wood bushing will prove satisfactory. Experience dictates that a wood bushing should run at a temperature not exceeding 110 degrees Fahr., with a load not over 30 pounds per square inch, and a rubbing speed of about 250 to 300 feet per minute. Lignum-vitae bearings, a common type of wood bearing, depend almost entirely for lubrication on the gum in the wood which makes up about one-third of the total volume of the wood. Of the many types of oilless bearings, wood is the lowest in initial cost.

Before describing other types of self-lubricating bearings, it might be well to dispel the ambiguity of the term "oilless." It is usually applied to types of bearings which will run for long periods without oiling, but depend for lubrication on oils, greases, wax or graphite in the bearing materials. The operation of practically every type of oilless bearing with the exception of rubber cutless bearings will

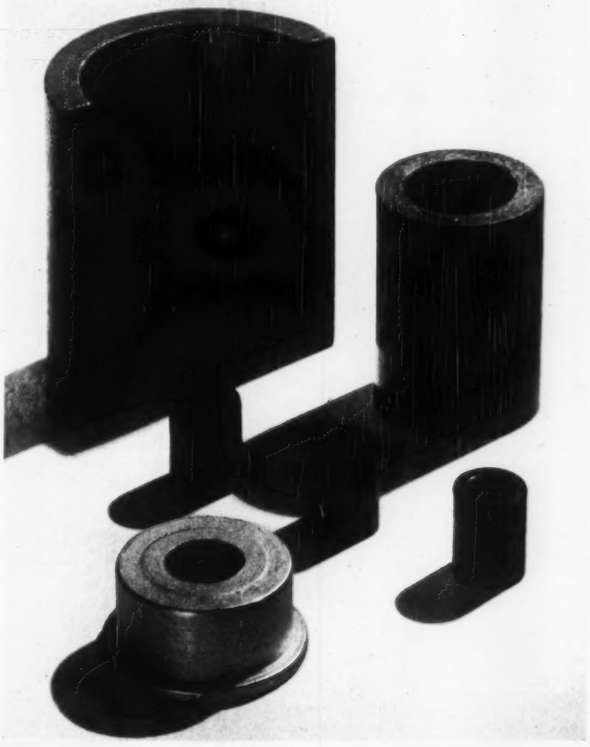


Fig. 3—Graphite is compounded with these textile base, resinous bearings to produce a self-lubricating surface

be improved with an adequate oil supply. The principal difference between an oilless and conventional type bearing is that no true oil film exists in the former between the bearing and journal. Rather, the bearing has a smooth, slippery surface with a low coefficient of friction which will not score or seize a revolving shaft.

Fiber bushings have been on the market for a number of years. Their principal application has been in fractional-horsepower electric motors and for small machine bearings, carrying light loads. Usual practice is to lubricate these bushings in assembly and because of the comparatively porous nature of the material, they will absorb sufficient oil or grease for long periods of operation. An important property of

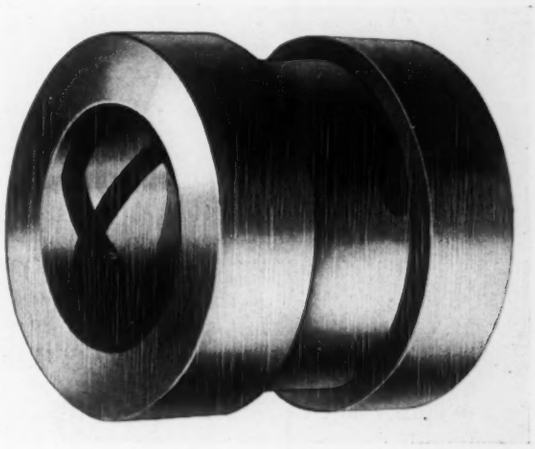


Fig. 4—Heavy bronze bushings with graphite-filled grooves provides lubricated surface for high temperatures

fiber bearings is that if run dry they will not score the shaft as would a metallic type. Other considerations in their selection are their noise and vibration dampening characteristics. Loads and rubbing speeds must be low, but limits are greater than for wood bushings. Ordinary corrosive fumes or solutions will not attack fiber bearings and for this reason they have found some applications in machinery handling acids or corrosive substances.

Plastic or laminated bearings are a modern development. The 1936 September and October issues of MACHINE DESIGN contain articles on the use of phenolic plastics for bearings. Several advantages are inherent in this type of bearing, but like wood and fiber bushings they are prone to swelling when heated or when soaked with a lubricant, necessitating a greater clearance than metal bushings. Except for applications where the load is very light, this type of bearing is usually reinforced with some binding material less susceptible to shock and more capable of absorbing a lubricant than the pure resinous substance. Wood flour is used as well as wood shavings in the form of excelsior. Paper has been used as a reinforcing agent, but most manufacturers have settled on various fabrics, such as linen, cotton duck and cotton belting. These materials reinforce the resin perfectly without any sacrifice of the low frictional coefficient of the pure resin.

Bearings of this type are not readily flammable and most commercial types produced now will continuously withstand a temperature of at least 275 degrees Fahr. Although heavy loads are not recommended for a plastic or laminated bearing, pressures

as great as 5000 pounds per square inch have been carried without failure. Though not as porous as wood or fiber materials, a laminated plastic bushing will absorb sufficient oil to enable it to run for long periods without additional lubrication. Even when the oil or grease contained in the bearing is exhausted, the plastic will not score the shaft. *Fig.* 1, shows a plastic (left) and a metal bushing (right) and two shafts that have been run dry. The scored finish of the shaft which ran in the dry metal bushing is easily seen, but the other retains a smooth surface.

The dry coefficient of friction of a typical resinous bearing is about 0.26. However, as can be seen in *Fig.* 2, the coefficient of friction becomes less with increased speed of the shaft when the bearing is water lubricated, reaching .0075 at 750 feet per minute. Usual practice in the manufacture of this type of bearing is to machine it to final dimensions, then give about 36 hours immersion in heated transformer oil to allow the material to soak up a quantity of lubricant. Manufacturers do not recommend that a laminated bushing be run without periodic lubrication, but they do claim that much less oil or grease is required than for metal bushings and that if lubrication is not adequate, scoring or seizing of the shaft is unlikely. As with fiber and wood bushings considerable reduction of noise and vibration is accomplished with a resinous laminated bushing. *Fig.* 3 is an example of a textile base, resinous bearing with compounded graphite as a lubricant.

Thousands of small sleeve and spindle bushings are employed in textile machines. Although wood bearings have been used almost universally for idler pulleys in this type of machine it was found recently that a plastic bushing would perform the same duty with longer life and allow closer shaft tolerances.

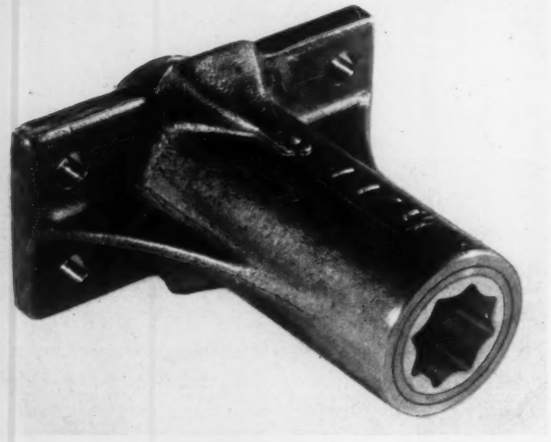


Fig. 5—Rubber bearing for propeller shaft reduces vibration and wear of shaft and will outlast many metallic bushings

Farm machines are now being equipped with plastic bushings. A certain dairy machine was equipped with oil-sealed, antifriction bearings. These operated satisfactorily, but when steam and hot water were used

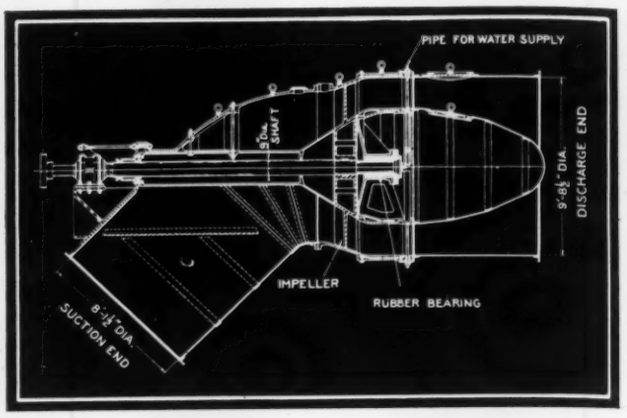


Fig. 6—Four tons are carried by a large rubber bearing in this special drainage pump

to clean the machine, oil in the bearings was washed away. Plastic resinous bearings were substituted and no further trouble was experienced.

Metallic self-lubricated bearings solve difficult problems for the designer. Many machines must operate in high temperatures where an oil or grease would soon be burned to a carbon. Conveyors of red-hot steel slabs, or machinery moving parts in ovens and furnaces is subjected to temperatures which would decompose the finest oils. Oilless bearings that will withstand higher speeds and heavier loads than wood, fiber or plastic bearings are needed on many machines. Water pumps in which an oil or grease would be washed away are a common application for oilless metallic bearings.

Probably the most common of several types of self-lubricated metallic bearings is the combination powdered metal and graphite type. These are made in hundreds of different metal-graphite ratios with a number of different metals being used as a base. Bronze is the most common although babbitt, tin, aluminum and other metals are used by different manufacturers. These bearings are made by squeezing the compounds together in dies under high temperature and pressure. Two large automobile manufacturers have factories devoted exclusively to making composition graphite bushings which are used in water pumps, for steering wheel bearings, and for generator and starter-motor shaft bearings. The percentage of graphite varies from a few per cent to over 50 per cent by weight. With a composition bearing, loads must be comparatively light and a solid bearing support provided, as the bushing itself is not strong. Temperatures may run as high as 750 degrees Fahr. without damaging a graphite bearing and clearances are little more than for the ordinary oil-film type. Porosity of this type of bearing varies greatly, some being little more than a metallic sponge; others are dense and hard. Because of the absence of a liquid film between the bearings and journal, graphite bearings are apt to be noisy and transmit vibration.

Another type of composition bearing which is com-

(*Continued on Page* 88)

Reflection Projection Simplifies Timing of Wrist Watches

By M. F. Manby
Chief Engineer, Hamilton Watch Co.

WHILE in the watch manufacturing industry magnification of tiny parts by profile projection is today of extreme importance both to the engineer and the production departments, there also are several other ingenious and useful applications of combined optical and mechanical equipment. One good example is that of our own development which we call the Time Projector.

Modern styles demand that a certain class of fine watches be made of very small size so that they will be relatively inconspicuous when worn on a lady's wrist. There also is a demand that the shape of their cases and of their dial openings shall be such that

Fig. 2—Above—The Time Projector in use, showing how the tilted position of the translucent screen makes for ease of reading—an important factor toward making possible the "timing" of more than 1000 watches per day by means of this instrument

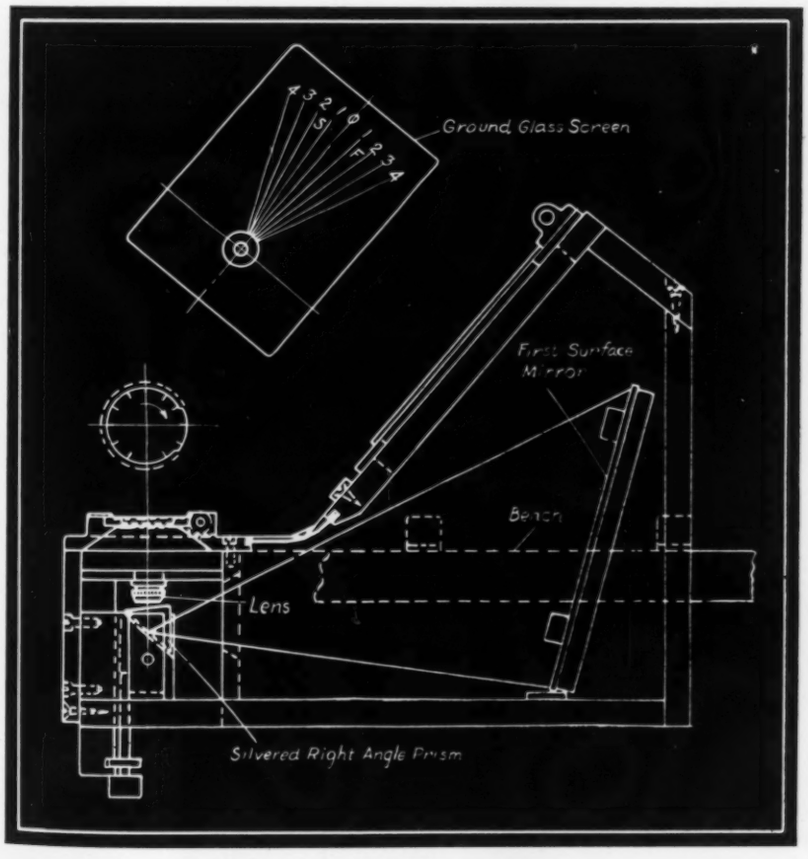


Fig. 1—Left—Side elevation of the Hamilton Time Projector with casing open to show arrangement of lens, prism, mirror and ground glass screen. Auxiliary views show dial of the built-in Telechron clock and radial time markings on the screen

the watch will represent a pleasing bit of jewelry as well as an instrument for telling time.

This matter of shape in particular has lead to wide deviation from the conventional round design, with the result that many of the newer wrist watch dials are much longer than they are wide. Inasmuch as the motion of the hands can be only in a perfect circle, the diameter of which must be held within the smallest dimension of the watch bezel, time actually can be read with high accuracy only when the minute hand is at or near to the horizontal position.

In carrying out the final timing of one of these oblong shaped watches, it must be read within a quarter of a minute once each day over a period ranging from five to fifteen days. To accomplish this it was formerly necessary to wait until the hands were in a position where they extend over the time-indicating track. This condition exists for a period of only ten

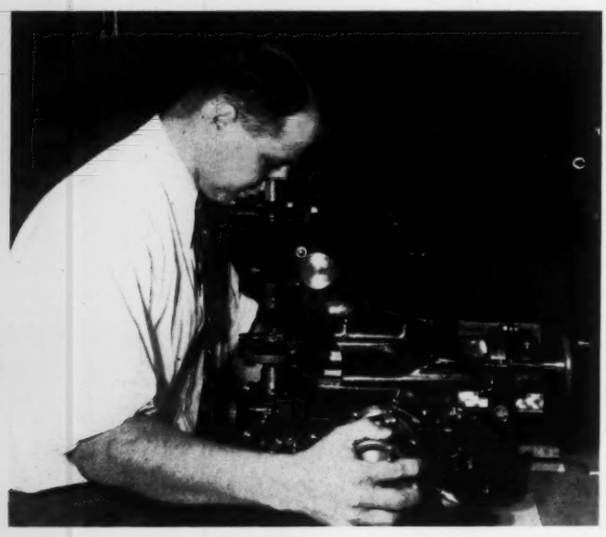


Fig. 3—Checking over a watch movement by means of a mechanical comparator with built-in microscope

to twenty minutes before and ten to twenty minutes after the hour—the extent of the period depending upon how oblong the shape of the watch happens to be. This requirement meant that the timer was out of work about two-thirds of the time.

This undesirable state of affairs has now been done away with—and the additional advantage of being able to rear the time error direct has been gained—by the application of a unique combination of an optical opague projection machine with a precision clock.

The general scheme of this apparatus as designed by the Hamilton Watch Co. is shown by the drawing, *Fig.* 1. It embodies a conveniently inclined ground glass screen marked with radial lines which correspond to minutes on the watch dial. Mounted in the front part of the device there is a revolving universal chuck designed to hold various shapes of watches, face down, always in the same relative position as far as the revolving chuck is concerned. This chuck is driven by a Telechron synchronous motor connected into the master precision clock system and so geared that the chuck revolves at the rate of exactly one revolution per hour.

When a correctly timed watch is placed in the chuck, its minute hand stands perfectly still as far as the frame of the apparatus is concerned. Furthermore, the chuck is designed so that the watch can be removed from it and replaced at any later time with the minute hand in exactly the same relative position to the frame that it would have been had the watch remained constantly in the chuck.

By means of an optical system made up of a highly corrected wide aperture lens placed vertically below the watch face, a silvered right angle prism immediately below this lens, and a tilted first-surface mirror, the image of the minute hand is projected by magnified reflection on the back of the tilted translucent screen. Powerful illumination of the dial is effected by means of two standard adjustable 100-watt microscope lamp units with spherical condensers. These focus their beams on the watch face from opposite sides at an angle of about 45 degrees. This arrangement eliminates troublesome reflections from the watch crystal, at the same time giving strong illumination to the minute hand which usually has a polished blue finish.

Image Shows Gain or Loss

In testing watches by means of this time projector, an operation which is illustrated by *Fig.* 2, each watch under observation is placed in the chuck once each day during the test period. Without looking at the master clock or even knowing what time it is, the timer can tell at a glance whether regulation is perfect or how many minutes the watch has gained or lost since the previous test. The position of the enlarged image of the hand on the diagram on the screen either on the center line or to the right or left of it tells the story, which is duly recorded pending the next days test. Under this system the timer is kept busy testing watches one after another all day long—over 1000 watches being read each day.

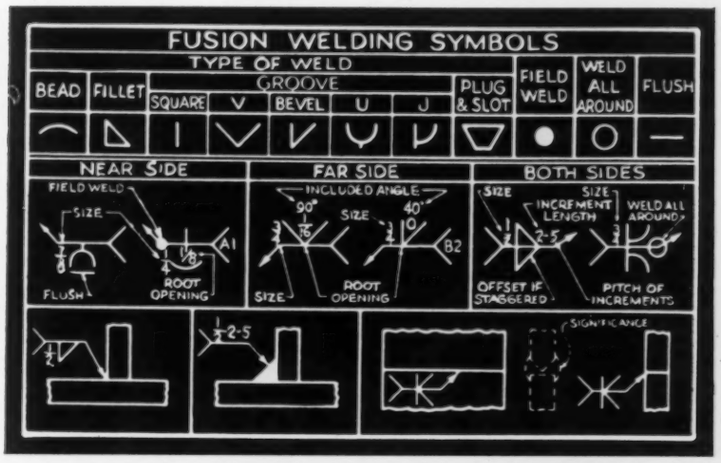
In addition to a number of special optical devices developed by our own engineering department, such as the Time Projector just described and the projection machine for checking the concentricity of escape wheels which was illustrated and described on pages 36 and 37 of the May, 1937 issue of MACHINE DESIGN, we are regularly using in our work many standard units of optical equipment. These include the Bausch & Lomb projecting machine and tool maker's microscope, the Zeiss optometer, several styles of binocular microscopes and the Dixi measuing and comparing machine. The use of the last mentioned instrument is depicted in *Fig.* 3, in which the operator is checking over a watch movement clamped on the table under the microscope.

New Welding Symbols Are Adopted

SUPERSEDING the welding symbols established in 1929 by the American Welding Society, and revised early in 1935 (M. D. April, 1935, page 36), a revised set of symbols has recently been developed. The new symbols are comprehensive and should be amply capable of relaying exact specifications from the designer to the welding operator. A new feature incorporated in this revision is the use of the tail of the reference line for referring to the welding specification reference to be used in making the weld.

The new system is flexible. Ordinarily the symbols would not interfere with dimensions and other details on drawings, but in the case of welds that are similar being placed in numerous locations on the same piece of equipment, some companies may find it desirable to set up their own "duplicate" signs that will clearly convey the meaning. This would ease the work of drawing in the complete symbols and would keep the drawing "clearer." Basically the system could retain the elements of the established standard, thus enabling all engineers and others identified with welding to speak the same language.

In the formulation of this revised symbol system the Welding Society's subcommittee under the chairmanship of L. C. Bibber, Carnegie-Illinois Steel Corp., has put through an accomplishment that should be highly appreciated in the field.



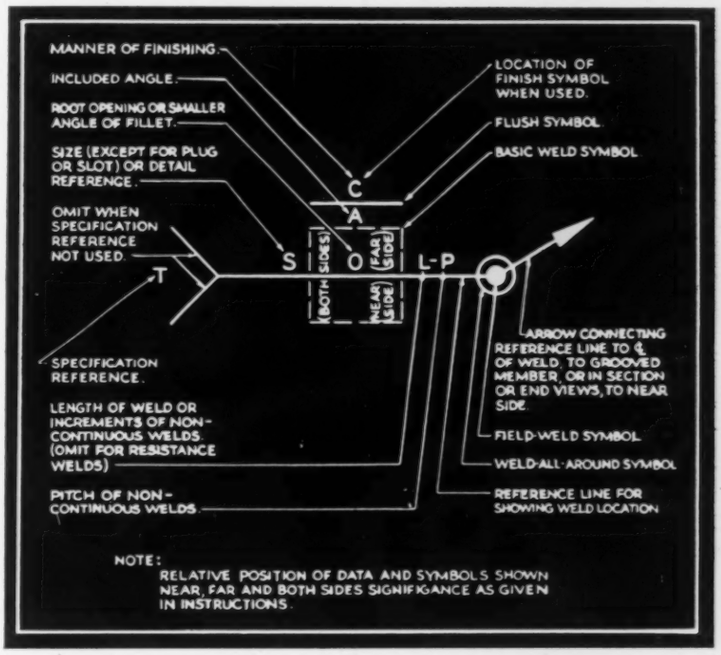

MANNER OF FINISHING
INCLUDED ANGLE
ROOT OPENING OR SMALLER ANGLE OF FILLET
SIZE (EXCEPT FOR PLUG OR SLOT) OR DETAIL REFERENCE
OMIT WHEN SPECIFICATION REFERENCE NOT USED
SPECIFICATION REFERENCE
LENGTH OF WELD OR INCREMENTS OF NON-CONTINUOUS WELDS. (OMIT FOR RESISTANCE WELDS)
PITCH OF NON-CONTINUOUS WELDS
LOCATION OF FINISH SYMBOL WHEN USED
FLUSH SYMBOL
BASIC WELD SYMBOL
ARROW CONNECTING REFERENCE LINE TO ℄ OF WELD, TO GROOVED MEMBER, OR IN SECTION OR END VIEWS, TO NEAR SIDE
FIELD WELD SYMBOL
WELD-ALL-AROUND SYMBOL
REFERENCE LINE FOR SHOWING WELD LOCATION
C
A
S
O
L-P
T
(BOTH SIDES)
(FAR SIDE)
(NEAR SIDE)
NOTE:
RELATIVE POSITION OF DATA AND SYMBOLS SHOWN NEAR, FAR AND BOTH SIDES SIGNIFICANCE AS GIVEN IN INSTRUCTIONS.

Fig. 1—Top—Typical illustration, for fusion welding, of symbols set up in new welding standard. The signs are largely pictorial, as can be seen from the key for bead, fillet welds, etc. Welding specification numbers can be included in the tails of the arrows

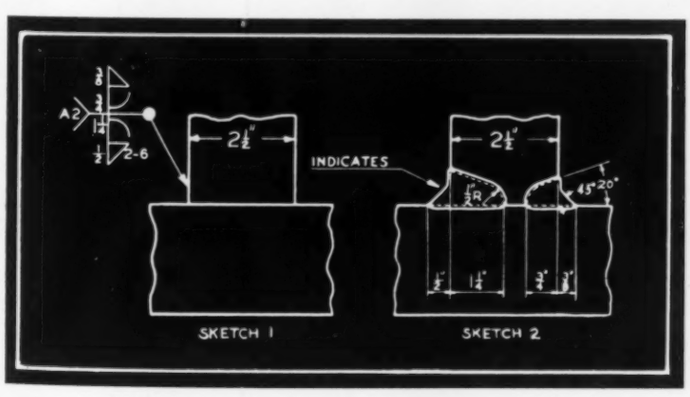
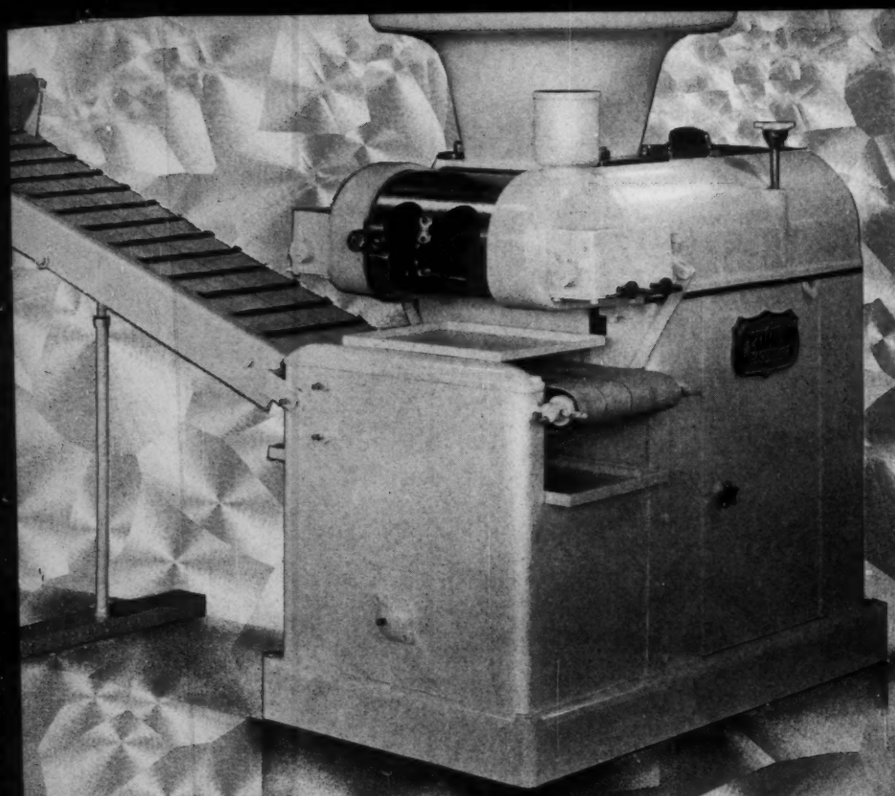


Fig. 2—Center—Information on weld, whether pictorial, dimensional or in other forms, is placed on the arrow in the standard locations indicated

Fig. 3—Left—Comparison between symbolic and diagrammatic methods of conveying information on welds. Note that complete data are contained in small area in the new system



Variable speed drive permits exact timing of conveyor belt in the Century dough dividing machine, left. Heavy counterbalanced crankshaft is used in place of cams, for speeding up the mechanism, allowing 2400 dividing operations per hour

Distinctive appearance is given this Hobart mixing machine, right, by a multi-sided design, unusual for domestic appliances. Lightness is obtained by an aluminum case and die castings. The one-sixth horsepower motor drives through worm gears

Safety features of the Oliver bread slicing machine, above, prevent machine starting until loaf is in place and automatically shuts off the current when slicing operation is completed. Knives and other exposed metal parts are of stainless steel to insure sanitation

Four-cylinder, air-cooled engine in the Lewis airmobile, below, develops 60 horsepower, enough to drive the 1600-pound vehicle 80 miles per hour. Clutch, transmission and differential with hypoid gear are in one housing. Drive is through two shafts to independently sprung front wheels

Design Features In New Machines

A Pictorial Presentation of Recent Machinery from the Standpoint of Design

A one-quarter horsepower motor drives this Unitor multiple-appliance machine, right, which combines dishwasher and clothes washer with a power takeoff for numerous household appliances. The machine is so designed that it may be bent over on the supporting pedestal to occupy less space

Two 900 horsepower diesels drive each unit of the Electro-Motive streamlined locomotive, below, giving a total horsepower of 3600. Traction motors are geared direct to the outer axles; the center axle is idle and only necessary for load carrying purposes. Blowers in the car body force cooling air over the motors

used for motor parts in this novel Moto-
obtain durability and reduce weight at low
a one-cylinder engine the scooter will
120 miles on a gallon of gasoline.
pushes the cycle for starting

New Machines Indicate

Design Trends

RUGGED individualism was not the only kind of ruggedness in vogue a decade or two ago. Many machines were built on the same theory as a safe—that massiveness and weight would impress purchasers with their safety and ruggedness—and it almost seemed as though manufacturers tried to outdo one another in constructing the heaviest machine. One huge industry, the railroads, suffered for years before realizing that their heavyweight equipment was mainly responsible for their decreased popularity. Today with lightweight trains capable of quick acceleration and fast stops the railroads are entering a new and prosperous era. Machine designers in most fields, after viewing the products of the aviation and automotive industries, have taken the cue and are now building for lightness and maneuverability rather than ponderousness. Just as rugged individualism gives way to social thinking, so is the heavy machine replaced with the light and easily-controlled model.

Amusement

Deck shuffler, Master Shuffler Sales Co., Los Angeles, Calif.

Brewery

Beer barrel reconditioner, Harnischfeger Corp., Milwaukee.

Coating

Roller coater, Colloid Equipment Co., New York.

Domestic

Custom-built export radio, Midwest Radio Corp., Cincinnati, O.
Oil-burning refrigerators, Perfection Stove Co., Cleveland.
Bathroom scale, Detecto Scales Inc., Div. of Jacobs Bros. Co. Inc., Brooklyn, N. Y.
Cabinet heater, Florence Stove Co., Gardner, Mass.
Equafonic radio, International Radio Corp., Ann Arbor, Mich.
Electric vacuum cleaner, Vacuum Cleaner Corp. of America, Philadelphia.
Stoker, Link-Belt Co., Chicago, Ill.
Folding fans, Lydon-Bricher Mfg. Co., St. Paul, Minn.

Foundry

Wheelabrator Tum-Blast, American Foundry Equipment Co., Mishawaka, Ind.

Hospital

Portable vacuum cleaner, Allen Billmyre Corp., New York.

Industrial

Sander, Clarke Sanding Machine Co., Muskegon, Mich.
Floor machine for scrubbing, polishing, etc., Fay Co., New York.
Air or gas compressor, Sullivan Machinery Co., Michigan City, Ind.

Materials Handling

Truck with hoist clamp, Kyle Sales Co., Decatur, Ill.
Paper roll truck, Mercury Mfg. Co. Inc., Chicago.
Portable crane trucks, Elwell-Parker Electric Co., Cleveland.

Metalworking

Polishing and buffing machine, Packer Machine Co., Meriden, Conn.
Pull-down broaching machine, American Broach & Machine Co., Ann Arbor, Mich.
Hydraulically operated machine for turning, Landis Machine Co., Waynesboro, Pa.
Gear lapping machine, Michigan Tool Co., Detroit.
Abrasive cut-off machine, Cincinnati Electrical Tool Co., Cincinnati, O.
Gear lapping machine, National Broach & Machine Co., Detroit.
Double-housing hydraulic planer, Rockford Machine Tool Co., Rockford, Ill.

Office

Interoffice call system, Bell Sound Systems Inc., Columbus, O.
Corner-rounder for letter heads, office forms, etc., L. A. S. Christie Co., Rochester, N. Y.
Seal presses, Art Novelty Mfg. Co., Chicago.
Postal scale, I. D. L. Mfg. & Sales Corp., New York.
Edge binder, Vertex Co., New York.
Counter register, Egry Register Co., Dayton, O.

Packaging

Check weigher for packages, Fred Goat Co. Inc., Brooklyn, N. Y.
Labeling machine, New Jersey Machine Corp., Hoboken, N. J.

Photography

Photo copy machine, Rectigraph Co., Rochester, N. Y.

Printing

Hydraulic paper drill, Challenge Machinery Co., Grand Haven, Mich.
Multiple punching machine, F. P. Rosback Co., Benton Harbor, Mich.
Offset press, Webendorfer-Wills Co. Inc., Mt. Vernon, N. Y.
Electric trimmer, Chas. W. Speidel & Co., Philadelphia.

Restaurant

Freezer and beater, Taylor Freezer Corp., Beloit, Wis.
Grinder, slicer, grater, etc., Reynolds Electric Co., Chicago.

Testing Equipment

Portable kitchen laboratory, Westinghouse Electric & Mfg. Co.

Welding

Arc welding machine, Wilson Welder & Metals Co. Inc., New York.

Production of Industrial Equipment Has Long Way to Go

MUCH has been said about the rapid increase in rate of production of durable goods, including capital equipment. From endeavors made by the national administration recently to discourage the expansion of the industries concerned in this production and to assist instead, by more or less direct means, the consumer goods industries, it might be accepted by many that such rapid progress had gone far enough.

That this is not by any means the case is evidenced by a recent research made by the Brookings institution which shows that to return to the 1929 standard of living by 1941, durable goods production during the next five years would have to be increased to a rate sixty per cent above that of 1936. The institution estimates that such a program would utilize the full time employment of from eight to nine million additional workers annually over the next five years.

Assuming that this rate of production could be achieved it is easy to visualize the flow of goods, both durable and consumer, that would be created. Further one can readily realize the immense increase in buying power, effected first by the higher employment in the capital goods industries and second by the manufacture on these machines of more products at lower prices—purchasable by a greater number of consumers. This is a condition toward which we all should aim.

• • •

New Directory Coming

SO MANY requests have been received for reprint copies of MACHINE DESIGN'S Directory of Materials (fourth edition) and so many inquiries have reached us regarding the publication of the next edition, that it would seem desirable to make an advance announcement of the fact that the fifth edition will be included as a removable supplement in the October issue.

Already information is being collected on new alloys, special steels, plastics and other nonmetallic materials used in the design of machines with which to bring up to date the listings included in the old directory. Code references indicating properties, by which—as well as by tradename—materials can be selected by the chief engineer or designer, are being revised and extended. Further, an additional cross reference listing under the company names of producers is this time being developed.

With selection of materials playing an increasingly important part in the work of the designer, and with the introduction of more and more materials from which to choose, the revised directory should find even greater acceptance than past editions among MACHINE DESIGN'S readers.

Professional Viewpoints

MACHINE DESIGN WELCOMES LETTERS SUITABLE FOR PUBLICATION

Believes in Status Quo

To the Editor:

YOUR leading editorial in the June issue of MACHINE DESIGN starts with the following sentence, "Because the normal growth of the country and—synonymous with it—the return of real prosperity, are dependent largely on the development of new industries . . . ." Have you any evidence to support such a claim?

I am well aware this statement has been broadcast by certain propagandists, and I am also aware that certain superficial arguments are presented to support it, such as the fact that new developments have generally come in periods of prosperity. But like most propaganda statements, careful reasoning is scorned, and the statement is usually made as dogmatically as yours.

But so far as I can see, as far as I have been able to search economic principles, I find no basis whatever for the claim. New developments occur in times of prosperity because only then is there the available capital and the confidence which enables men to proceed with the introduction of a new thing on a large scale. But what evidence I can find points to the conclusion that new developments act as brakes on coming prosperity.

In a time like the present, when people are so generally longing for a chance to get the old things which they have had to go without, what possible gain can there be in inducing them to get some new thing instead of the thing they now want? Doubtless they will buy the new thing. They may buy television sets which you mention, but only at the expense of other industries which make the old things they otherwise would have bought, only with a disturbance of existing conditions which must retard recovery.

—A. W. FORBES
Forbes & Myers, Worcester, Mass.

Mr. Forbes' comments are welcome. The statement at the beginning of the editorial in question—besides being to our mind, fundamental—is based on a comprehensive survey by one of the largest manufacturing concerns in the world, and supported by the history of former business slumps and prosperity periods in this country. It would be interesting to hear the thoughts and experiences of other readers on this subject—EDITOR.

Grease Specifications Changed

To the Editor:

SINCE the article "Engineering Department Should Specify Correct Lubricants" was published in the May issue of MACHINE DESIGN, there have been several changes in the lubrication specifications of our looms which were used as examples in the article. In the specification sheet published with the article a grease with a soda soap base was recommended for roller or antifriction bearings and a grease with a lime soap base for plain bearings. After extensive tests our laboratory has found that a grease with a mixed soda-lime base is suitable for both types of bearings. As in our original specifications this grease should be of A. S. T. M. penetration, 240/300 approximately. We recommend that a grease such as Starfak No. 2 with mixed base, manufactured by the Texas Co., or its equivalent be used for plain and antifriction bearings for Crompton & Knowles looms.

—ALBERT PALMER
Crompton & Knowles Loom Works

Patent Book Soon Available

To the Editor:

YOUR excellent magazine, MACHINE DESIGN, is available at our library and I have been a constant reader of it for several years. In the past there has appeared a series of articles on "Patenting of Inventions" which I understand will be published in book form. As I would be interested in purchasing a copy would you please inform me if it is now on the market and at what price, or if it will be published soon?

—K. J. DEJUHAZ
State College, Pa.

EDITOR'S NOTE: Mr. G. V. Woodling's original articles on patents have been revised and supplemented by additional chapters by the author. In all probability the

(*Continued on Page* 84)

MEN of MACHINES

WILLIAM B. MAYO, former chief engineer of the Ford Motor Co., has been appointed consulting engineer of the Hupp Motor Car Co., Detroit.

Mr. Mayo was born at Chatham, Mass., in 1866. For thirty years he served with the Hoovens, Owens & Rentschler Co. in various capacities, including those of chief engineer, general manager of the plant at Hamilton, O., and as a director and vice president of the company. He joined the Ford company in 1913 when large gas-steam engines developed by him were installed at the Highland Park plant. For several years prior to his retirement in 1932 Mr. Mayo was in charge of the aviation division of the Ford company which played a notable role in the early commercial development of all-metal airplanes.

WILLIAM B. MAYO

• • •

APPOINTMENT of Warner S. Hays as managing director of the American Welding Society is an important step in the program of advancement of this organization, the membership of which is growing rapidly.

Mr. Hays, who attended high school in Scranton, Pa., is a graduate of Sheffield Scientific school, where he specialized in electrical engineering. He spent several years with the General Electric Co. at Schenectady and Pittsfield in the testing and engineering departments. Since that time he has had managerial experience with public utilities in Illinois and in the technical publishing business in New York. During the war he served as an officer in the construction division of the army.

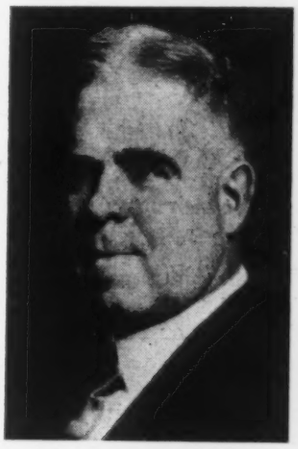
Since the war Mr. Hays has maintained his own office in Philadelphia as a consulting engineer and association executive.

WARNER S. HAYS

• • •

ELECTION of Dr. Albert E. White to the presidency of the American Society for Testing Materials was announced on June 28 at the fortieth annual meeting of the society in New York.

Dr. White was born at Plainville, Mass., in 1884. He graduated at Brown university in 1907 with an A. B. degree and during the following year he carried on graduate work at Harvard. After two years with the Jones & Laughlin Steel Co. in charge of research on blast furnace by-products, ores, etc., Dr. White came to the University of Michigan as an instructor in chemical engineering, being promoted to assistant professor in 1913 and full professor in 1919. When the Department of Engineering Research was organized in 1920, Dr. White was appointed to his present position as its director. During the war he served first as head of the



ALBERT E. WHITE

Metallurgical Branch, Inspection Division, and later on the technical staff of the Ordnance Department, in which he was promoted to be a lieutenant colonel.

Dr. White has been president of the American Society for Metals and is a member of the American Chemical Society, the American Institute of Mining and Metallurgical Engineers, the Advisory Committee of the National Research Council, and of Sigma Xi. In 1925 he was given the honorary degree of Doctor of Science by Brown University.

♦ ♦ ♦

FRANK F. WATTS has been named vice president of Hupp Motor Car Corp., Detroit. He still continues in his capacity of chief engineer.

♦ ♦ ♦

J. D. MCLEOD, formerly with the Chevrolet Motor Division, General Motors Corp., has been appointed vice president and general manager of Copeland Refrigeration Corp., Detroit.

♦ ♦ ♦

DR. JOHN S. PLASKETT, C.B.E., F.R.S., who until recently was the head of the Dominion Astrophysical observatory, Victoria, B. C., becomes scientific consultant on telescope design for Warner & Swasey Co., Cleveland.

♦ ♦ ♦

E. B. NEWILL, chief engineer and director of research of Frigidaire division, General Motors Corp., has been promoted to assistant general manager. S. M. SCHWELLER has been made chief engineer and director of research; he formerly was assistant chief engineer.

♦ ♦ ♦

FREDERICK G. BANNING, formerly with the scientific apparatus department of Cornell university medical college, has joined Designers for Industry Inc., Cleveland, as chief engineer in charge of engineering development.

♦ ♦ ♦

HOWARD A. FLOGAUS has been appointed coach engineer by the Reo Motor Car Co., Lansing, Mich. He was for seven years with Yellow Truck & Coach Co.

♦ ♦ ♦

J. H. VAN CAMPEN has resigned as chief engineer at the Corrigan-McKinney division of Republic Steel Corp., Cleveland to assume new duties with H. A. Brassert Co., Chicago.

♦ ♦ ♦

I. D. APPLEGATE, formerly with the Westinghouse Electric & Mfg. Co., has been placed in charge of engineering, design and development of automatic voltage current and speed regulators, with the Ideal Commutator Dresser Co., Sycamore, Ill.

♦ ♦ ♦

LOUIS ALLIS, president of the Louis Allis Co., Milwaukee, received the degree of Doctor of Electrical Engineering during the commencement exercises of the Pennsylvania Military college, Chester, Pa., from which he graduated with honors in 1888.

♦ ♦ ♦

ROBERT W. MENEILLY has been made assistant to C. F. W. Rys, chief metallurgical engineer of Carnegie-Illinois Steel Corp., Pittsburgh.

♦ ♦ ♦

E. H. KOENIG, formerly chief engineer of Republic Steel Corp., Youngstown, O., has been appointed sales engineer of Freyn Engineering Co., Chicago. He previously had been identified with the latter company.

♦ ♦ ♦

DR. FREDERICK M. BECKET, president of Union Carbide & Carbon Research Laboratories Inc., New York, has been awarded the Acheson medal of the Electrochemical Society for his outstanding contributions to electrometallurgy.

♦ ♦ ♦

WILLIAM G. HARVEY, of the Aluminum Co. of America, Cleveland, has been elected president of the Electrochemical Society.

♦ ♦ ♦

FRANCIS HODGKINSON, who retired as consulting mechanical engineer of the Westinghouse Electric & Mfg. Co. about a year ago, has been appointed honorary professor of mechanical engineering at Columbia university. (Note: A biographical sketch and photograph of Mr. Hodgkinson was included in the August, 1936 issue of MACHINE DESIGN.)

♦ ♦ ♦

JOHN J. ROSS has been made president of the new Detrola Radio Co., division of Detrola Radio & Television Corp., Detroit. FRANK WEST, formerly with Kelvinator Corp. and Copeland Refrigerator Corp., is chief engineer.

♦ ♦ ♦

MALCOLM F. JUDKINS has been appointed chief engineer of the Firthite division of Firth-Sterling Steel Co., McKeesport, Pa. Mr. Judkins received his master of science degree from Carnegie Institute of Technology in 1929, and is chairman of the American Society of Mechanical Engineers, sub-committee on metal cutting materials.

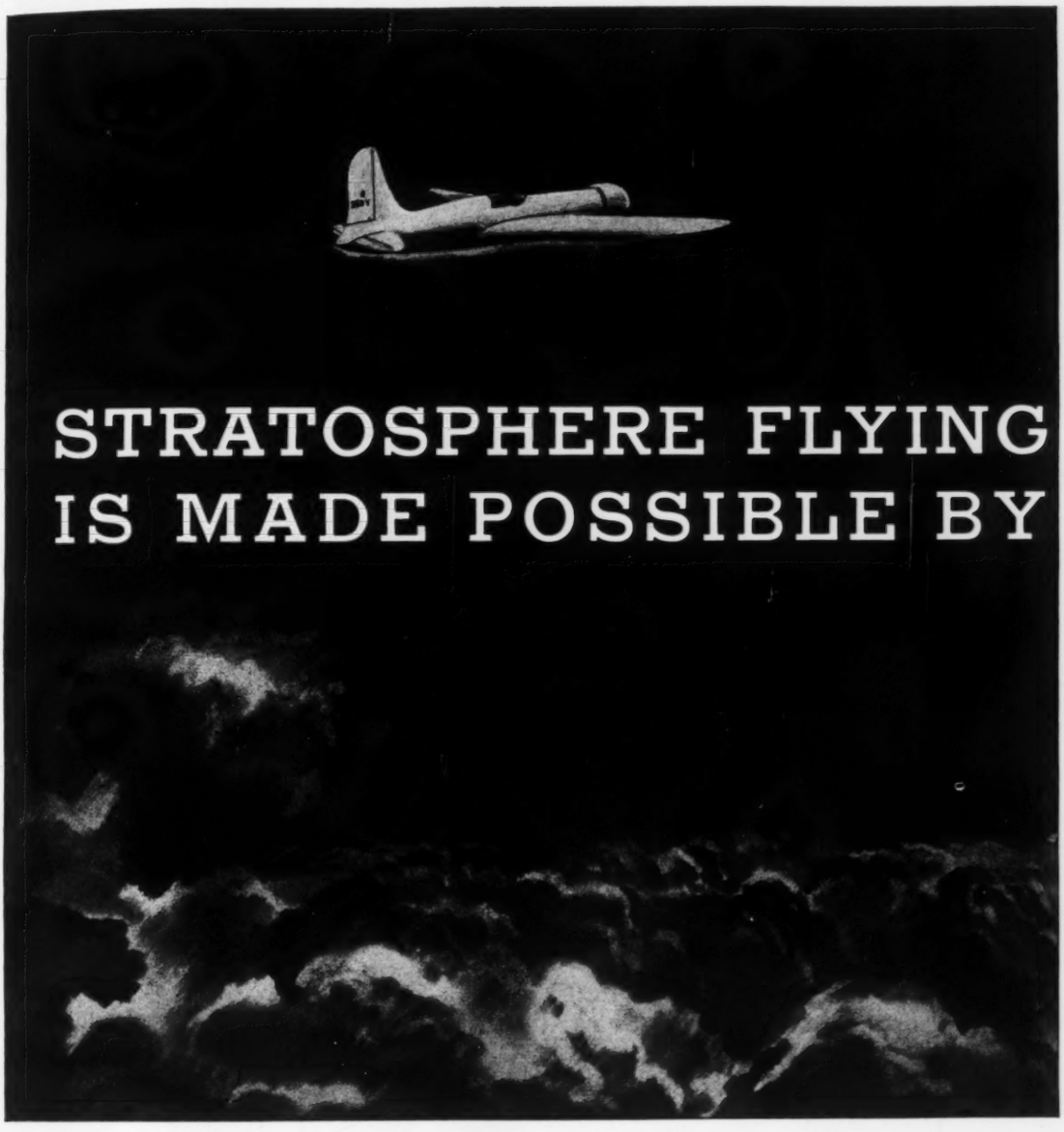
♦ ♦ ♦

FRED L. PLUMMER, consulting engineer and associate professor of structural engineering at Case School of Applied Science, Cleveland, has been elected president of the Cleveland Engineering Society.

♦ ♦ ♦

DR. LEON PRATT ALFORD, engineer-editor, will succeed JOSEPH WICKHAM ROE as professor of administrative engineering and chairman of the department of industrial engineering, College of Engineering, New York University. Mr. Roe is retiring as professor-emeritus after sixteen years of teaching and ad-

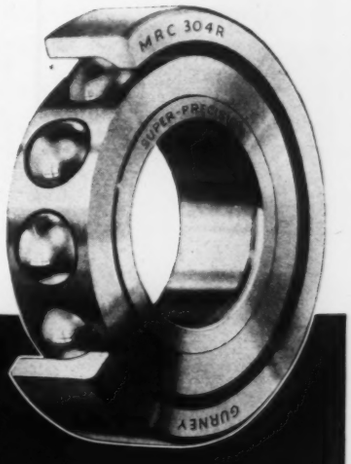
SUPER-PRECISION



STRATOSPHERE FLYING IS MADE POSSIBLE BY

M-R-C Strom SRB Gurney Ball Bearings

● At 30,000 feet above the earth, where the stratosphere begins, atmospheric pressure is only four pounds to the square inch and motors must be supercharged. M-R-C Super-Precision Ball Bearings in these super-chargers make as high as 34,000 revolutions per minute. Only the world's finest ball bearings will stand up in such service. ● In machine tools M-R-C Super-Precision Ball Bearings give up to 7000 hours life at 25,000 r. p. m.—a common speed today in internal grinders. At this speed the balls make 1,000,000 revolutions every 20 minutes. ● M-R-C Super-Precision Ball Bearings are the world's finest ball bearings. They are a commercial, not a laboratory product. Because the methods developed for their manufacture have been applied to other grades—every M-R-C Ball Bearing is a better bearing than it would be if M-R-C Super-Precision bearings did not exist. ● When buying bearings consider the source. M-R-C standards have set the pace.



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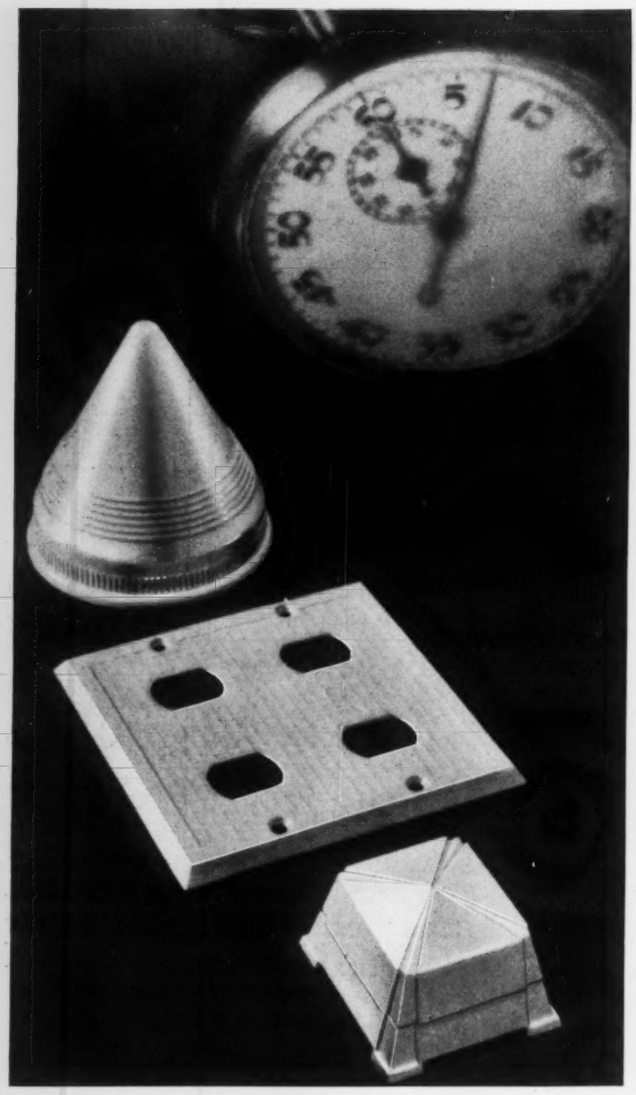
M-R-C *Ball Bearings*
GURNEY ● SRB ● STROM

M-R-C SUPER-PRECISION BALL BEARINGS ESTABLISH NEW STANDARDS OF ACCURACY



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Excuses don't meet production schedules. Therefore when you choose your molder of plastic parts the facilities of that molder are of utmost importance.

As one of the oldest and largest molders of plastic parts our production facilities have steadily expanded in keeping with the constantly increasing demand for Auburn products. As a result you can place your order with Auburn with confidence that there will be no delay in meeting your production schedule. You will find it to your advantage to put our sixty years of experience to work on your problems.

Established 1876

MOLDED PLASTICS DIVISION OF
AUBURN BUTTON WORKS, Inc.
AUBURN, N.Y.

ministrative service. Dr. Alford holds the Admiral Melville gold medal for contributions to the literature of mechanical engineering.

Obituaries

AMBROSE SWASEY of Cleveland, dean of the American machine tool industry and noted builder of astronomical telescopes, died at his summer home in Exeter, N. H., on June 15. He was 90 years old.

Mr. Swasey was born in Exeter where he attended the village schools and began his mechanical career at the Exeter Machine Works. In that shop he met Worcester R. Warner with whom he was destined to be intimately associated for more than fifty years. About 1870 these two ambitious and studious young men went to the Pratt & Whitney Co., Hartford, Conn., where both advanced rapidly to responsible positions.

Sensing that the middle west represented a great potential market for high grade production machinery, Worcester Warner and Ambrose Swasey decided to launch a business of their own in that part of the country. In 1880 they made their initial attempt in Chicago, but finding that they were beyond the range of skilled workmen, they moved to Cleveland in 1881.

There the project took root and developed rapidly into one of the leading turret lathe plants, where also have been designed and built the telescopes for many of the world's greatest observatories. Mr. Swasey, who outlived Mr. Warner by nine years, was chairman of the board of the Warner & Swasey Co. at the time of his death.

A generous patron of science and the arts, of organized engineering and of undertakings for public betterment, and an active member of numerous technical and scientific societies both here and abroad, Ambrose Swasey received hundreds of honors. He was an Honorary Member and past-president of the American Society of Mechanical Engineers and one of its last surviving founders.

♦ ♦ ♦

JOHN CHRISTENSEN, president of the Cincinnati Gear Co., died recently of a heart attack on board ship enroute for England. He was 67 years of age.

Mr. Christensen, who established his business in 1907, was one of the founders of the American Gear Manufacturers' association.

TIPS ENGINE
COOPER-BESSEMER
OTTO
FRANKLIN VALVELESS
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STANDARD DIESEL
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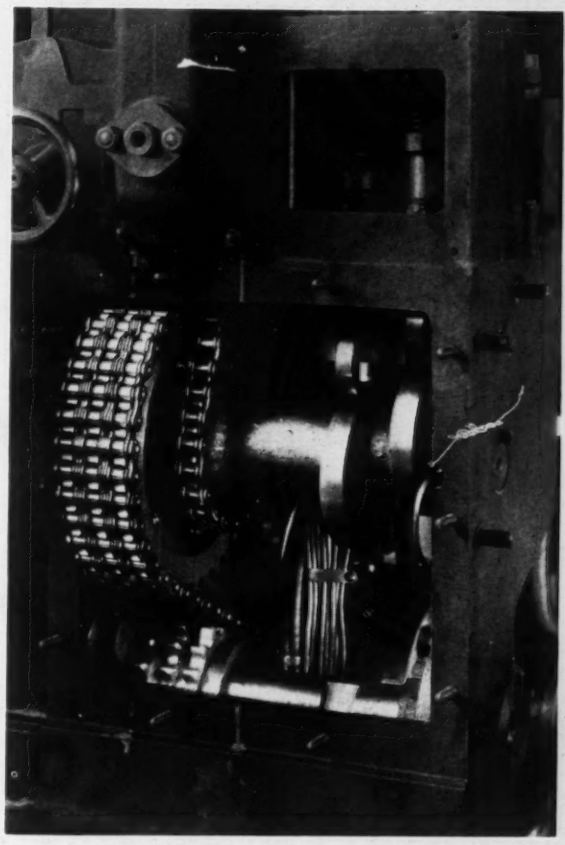
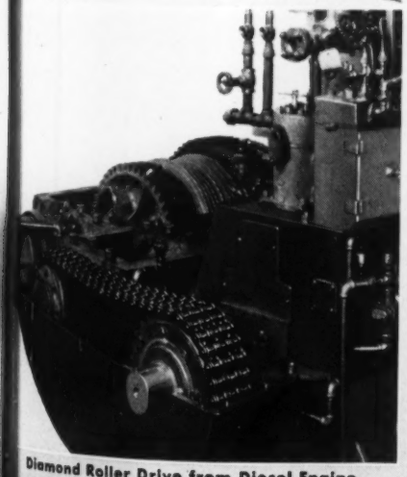


Typical Diamond Drives for cam shaft—fuel, lubricating, and water pumps.

The Diamond Mark on Every Link

ELEVEN YEARS OF DIAMOND DIESEL DRIVE SERVICE

Among the Diesel engine builders using Diamond Drives, the first user, supplied 11 years ago, is still equipping his engines with DIAMOND. ● Enduring split-second accuracy—long trouble-free life—quietness—simplicity and flexibility of application—have been proven during these 11 years, driving cam shafts—fuel, water, and lubricating oil pumps, and generators. In fact Diesel engine buyers have come to look upon the use of Diamond Drives as additional evidence of the worth of the engine. ● ● Diamond Power Drives are used also for transmitting engine power to station generators, pipe line pumps, oil country rigs, and all types of motor-driven plant machinery and equipment. ● Suggestions and recommendations on machinery applications and power drives will be made gladly on request. DIAMOND CHAIN & MFG. CO., 435 Kentucky Ave., Indianapolis, Ind. *Offices and Distributors in Principal Cities.*



Diamond Roller Drive from Diesel Engine to heavy logging hoist.

DIAMOND ROLLER CHAIN

ALL TYPES OF
GEARS

Cut Spur, Straight and Spiral Bevel, Mitre, Spiral, Worm, Internal, Helical and Herringbone Gears, in all sizes and of all materials, Sprocket Wheels, Racks, Flexible and Universal Couplings

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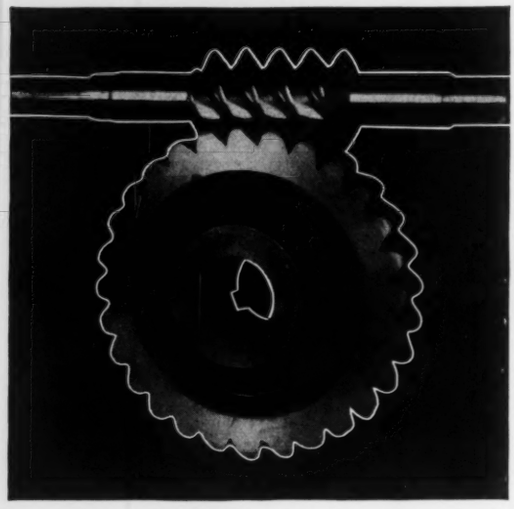


Almost a half century of making all types of cut gears for every conceivable purpose has proved the D.O. James service a valuable one. Speedy production without sacrificing D. O. James manufacturing perfection assures you of quality gears *when you need them.* We offer you the accumulated experience, skill and knowledge of fifty years of successful gear making. Let us help you with your next requirements.

WRITE FOR CATALOGS AND BULLETINS

D. O. JAMES
MANUFACTURING CO.
Established 1888
1120 West Monroe Street • Chicago, Illinois

Noteworthy Patents

AN INTERNAL combustion engine which rotates around a stationary shaft has been patented by William H. Card of Los Angeles. A transverse cross section of this engine appears herewith as *Fig.* 1.

The body of the engine, which is its own flywheel, has as its foundation a tubular member to which the cylinder blocks are fastened. In the design shown, each block contains two cylinders. The pistons in each pair of cylinders reciprocate synchronously. While one is moving in a power stroke, its companion is drawing in a charge of fuel mixture. At the same time one of the other pair is expelling exhaust gas while its companion is compressing a fresh charge preliminary to firing.

The main object of the invention is to make a simple, compact and efficient motor of light weight in relation to its power. At the same time accessibility is sought. Roller bearings are provided for throughout and these bearings run constantly in a spray of oil.

Considerable weight is saved in the connecting rod arrangement. These rods are floatingly pivoted, each to the end of a rocker arm. The opposite ends of the rocker arms are fixedly pivoted in relation to the cylinder block assembly while at their centers they are pivoted to a strap which is journalled to an ec-

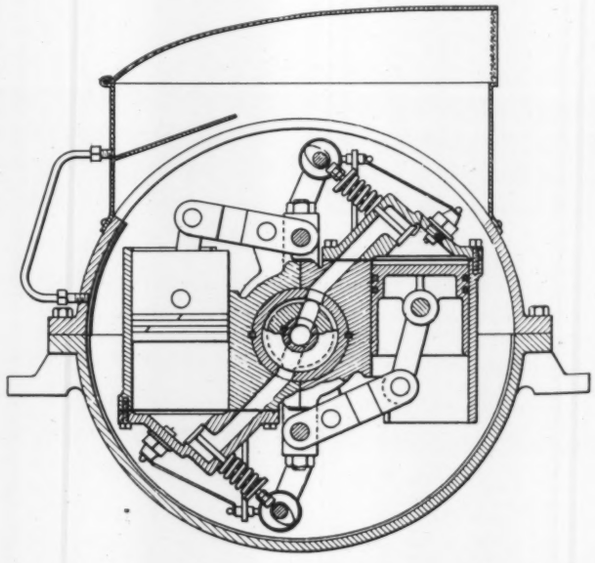
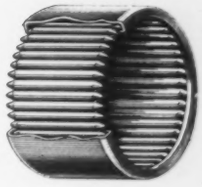


Fig. 1—*Revolving internal combustion engine of unusual design acts as its own flywheel*

The Torrington Needle Bearing

uses Standard Method of Selection



USUAL SAFETY FACTORS EMPLOYED IN APPLICATION OF NEW DESIGN PRINCIPLE

OPERATING conditions, required length and type of service, proportion of total load carried, method of lubrication . . . all affect the proper bearing selection. The engineer or designer must have an accurate method of compensating for these variable conditions to determine the proper bearing.

Balanced design requires that the most economical type bearing be employed. For example, it is not practical to put expensive bearings into machinery where less expensive bearings will fulfill every requirement. Nor is it advisable to select a bearing which will give limited service where the cost of replacement exceeds the cost of a proper bearing.

While the Torrington Needle Bearing represents a new principle in bearing design, the method of selecting the correct size for any given application is similar to the established method used for other standard types of anti-friction bearings, so that the designer may readily determine the size Needle Bearing best suited to his applications and make a definite comparison of the advantages it offers.

Usual Safety Factors Employed

As the catalog load ratings for the Torrington Needle Bearing are based on 3,000 hours of life at various R.P.M. under ideal conditions (clean lubricant, constant speed, uniform load), a safety factor is used to allow for actual operating conditions in various types of machinery. The safety factor is the product of the three following factors:

Installation Factor, representing type of machine, varying between limits of 1 for a precision machine of rigid construction and 2 for a roughly built machine lacking rigidity and alignment.

Duty Factor, representing type of loading, varies between limits of 1 for steady loading and intermittent operation and 2 for shock loading and continuous service.

Life Factor, representing total hours of service life required, varies between limits of 1 for 3,000 hours and 2 for 25,000 hours.

For A New Application

For illustration, a manufacturer is designing a new electric motor on which he wishes to use Torrington Needle Bearings.

TORRINGTON Needle Bearing Application	Installation Factor	Duty Factor	Life Factor	Total Factor
Conveyors	2	2	2	8
Farm Tractors	1.6	1.5	1.5	3.6
Hoists and Trolleys	1.5	1	2	3
Machine Tools	1.2	1.5	2	3.6
Portable Tools	1.1	1	2	2.2
Shop Trucks	2	1.5	2	6
Washing Machines	2	1	1	2

Typical Safety Factors for a Few of the Applications Where the Torrington Needle Bearing Offers Advantages

The motor is designed for mass production. It will operate intermittently over a 24-hour period at 1500 R.P.M., under a load of 50 pounds. 25,000 hours life service is desired.

The Installation Factor is about 1.25.

The Duty Factor is about 1.7.

The Life Factor is 2.

To determine the running load, multiply 50 pounds by the product of 1.25 x 1.7 x 2 or 4.25 which gives 212.5 lbs. Consulting the Torrington Needle Bearing Catalog under 1500 R.P.M., the manufacturer finds the B-812 (½" I.D.) Torrington Needle Bearing best fits his requirements.

For An Established Design

Another manufacturer wishes to use a Torrington Needle Bearing in his product without changing the design. Size limitations, replacement sales, etc., require the use of the B-912 (9/16" I.D.) Torrington Needle Bearing. He wishes to check this size for use in his product. His load is 40 lbs. and speed is 3600 R.P.M. His product is well made but not to very close limits so he considers the installation factor to be 1.7. Continuous operation over an 8-hour period is required so 1.5 is the duty factor. 10,000 hours bearing life is necessary so the life factor is 1.5. The product of the factors is 3.825.

The Torrington Catalog gives the rate of the B-912 Torrington Needle Bearing at 3600 R.P.M. as 270 lbs. This, of course, is based on ideal conditions, so he divides the 270 lbs. by the total factor value of 3.825. The answer is 70 lbs., 30 lbs. *more* than his actual load, so that the B-912 Torrington Needle Bearing will give good service in his product.

A representative of the Torrington Engineering Department will be glad to go over with you the application of the Torrington Needle Bearing to your own product. Detailed information on types and sizes available, and the advantages it offers, are outlined in the Torrington Needle Bearing Catalog available on request. Write for Catalog No. 9.

The Torrington Company
ESTABLISHED 1866
Torrington, Conn., U.S.A.

Branch Offices in all Principal Cities

TORRINGTON
NEEDLE BEARING

CONFIDENCE in people or things has to be *earned*—usually through repeated testings.

The steady growth of Cleveland Worm Gear sales is a fine example of earned confidence—because repeat orders from established customers comprise a substantial share of each year's new business.

Worm Gear Drives and Speed Reducers are this Company's exclusive product. For a quarter-century, leaders in one great industry after another have been applying "Clevelands" to their respective production machinery. Throughout these widely-diversified industries, thousands of Cleveland Worm Gear Speed Reducers installed 10, 15 or 20 years ago, are still giving steady, unfailing service.

Whatever *your* proposed application for Worm Gear Units, call in a Cleveland Representative. Backed by the Company's long experience in building Drives for difficult as well as standard applications, his counsel should prove valuable. The Cleveland Worm & Gear Company, 3275 East 80th Street, Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication.

CLEVELAND *Worm Gear Drives*

centric portion of the stationary shaft about which the assembly revolves.

Two points brought out by the inventor are: That the eccentric action causes the pistons to travel slower on the power and intake strokes than on the exhaust and intake portions of the cycle; and that centrifugal action due to the spinning of the engine around its central shaft is utilized to cool the sprayed oil and to return it to a reservoir for use again.

One half interest in this patent, which is identified by No. 2,075,786, has been assigned to Harry M. Swensen of Los Angeles.

HIGH accuracy and finish comparable to that of precision gages is demanded on bearing rollers. At the same time the volume in which they are needed and price considerations dictate that they must be finished by an economical mass production method.

Grinding and lapping after hardening has been recognized as a standard method of sizing and finishing these rollers. Heretofore, however, this has meant two operations—one for the circumference and another for the thrust ends. The primary object of the invention about to be described is reduction in cost of grinding and lapping through simplification of the process and machinery for carrying out this work, this without sacrificing accuracy and finish. Alvin B. Einig, the inventor, has assigned his recently granted

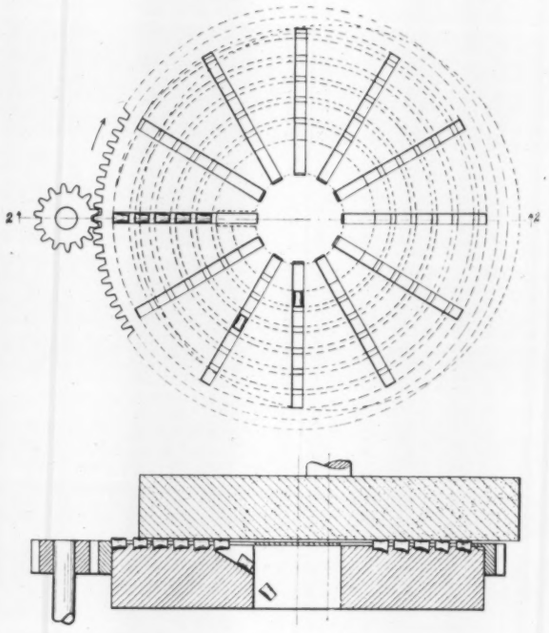


Fig. 2—Bearing rolls are lapped on periphery and thrust ends as they roll in spiral groove

A GRIP ... THAT REALLY HOLDS .....

UNSHAKO

SELF-LOCKING NUT

Fig. 1510 (above) *Cutout section of UNSHAKO Nut, showing Locking Ring in position.*

Once in, no amount of jarring or vibration can loosen the UNSHAKO Self-Locking Nut. (*Yet it backs off easily with the aid of an ordinary wrench.*)

The built-in, self-locking ring or floating thread holds it fast (without fuss with straying pins or washers) and absolutely prevents accidents and failures from loosened nuts in vibration wracked machines.

Complete information and prices cheerfully furnished.

STANDARD PRESSED STEEL CO.

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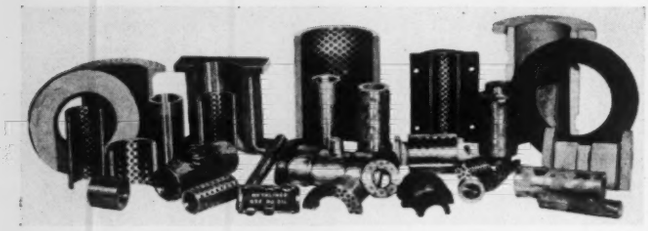
BRANCHES CHICAGO ST. LOUIS SAN FRANCISCO

METALINE
OILLESS BRONZE
BEARINGS



● Our many years of service to industry has taken us into a variety of machinery installations. Therefore we are in a position to recommend the ***correct design***, type of bronze and grade of Metaline for industrial applications.

You are relieved from bearing worry once our engineers have studied your problem and issued specifications. Metaline Oilless Bronze Bearings are strictly oilless, therefore troublefree.

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Metaline Bearings are working day in and day out in machinery for the following industries:

STEEL TEXTILE FOOD
RUBBER CHEMICAL PAPER

R. W. RHOADES METALINE CO.
INCORPORATED
40-17 Fifth St., Long Island City, N. Y.

patent to the Motch & Merryweather Machinery Co. of Cleveland.

In *Fig.* 2 there is shown in section and diagrammatically the vital portion and the scheme of operation of the machine developed by Mr. Einig for the continuous and simultaneous grinding or lapping of body and thrust ends of tapered rollers. The base, or roll support, is a thick stationary disk which may be of metal, an abrasive composition, Bakelite or other suitable material. In its upper surface there is cut a spiral track which begins at the extreme left and proceeds in a clockwise direction to the point where the inclined chute leads to the central opening in the support disk.

For handling tapered rollers, the bottom of the spiral track is inclined at such an angle as to bring the upper surfaces of the rollers horizontal to the lower face of the grinding or lapping wheel. Also the radial outward sidewall of the track is inclined to form an angle with the track which is equal to that between the thrust end and peripheral surface of the rollers. If the support is not of an abrasive material, this sidewall is charged with grinding compound.

On top of the support disk is mounted a roll carrier which consists of a thin, radially slotted disk having a ring gear flange which is a running fit on the support disk. This disk is driven in a clockwise direction by the pinion at the left.

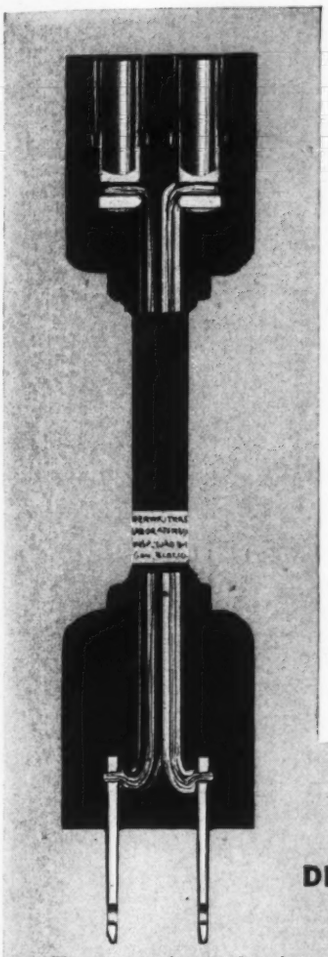
The grinding or lapping disk, formed of suitable abrasive material, revolves above the support disk in the same direction as the roll carrier but at a very much higher rate of speed. It will be noted that the axis of this grinding disk is offset considerably to the right of the axis of the support disk. This offset causes a portion of the left side of the carrier and supporting disk to be at all times exposed, which permits the rollers which are to be ground to be deposited successively one at a time in the outer ends of the slots in the roll carrier and at the same time in the outer end of the spiral track in the support disk.

The action of the slowly revolving carrier disk is to sweep the rollers along the spiral track in the support disk toward and finally into the discharge chute at the center. During this relatively long journey, during which they roll along the bottom of the spiral, the rollers are ground or lapped on their rolling surface by the revolving disk above them, and receive the same action on their thrust ends through contact with the abrasive side wall of the spiral, against which they rub as they roll along.

The number of Mr. Einig's patent is 2,075,104.

VINCENT BENDIX of South Bend, Ind., has been granted a patent on an automobile brake which departs radically in its design from the conventional

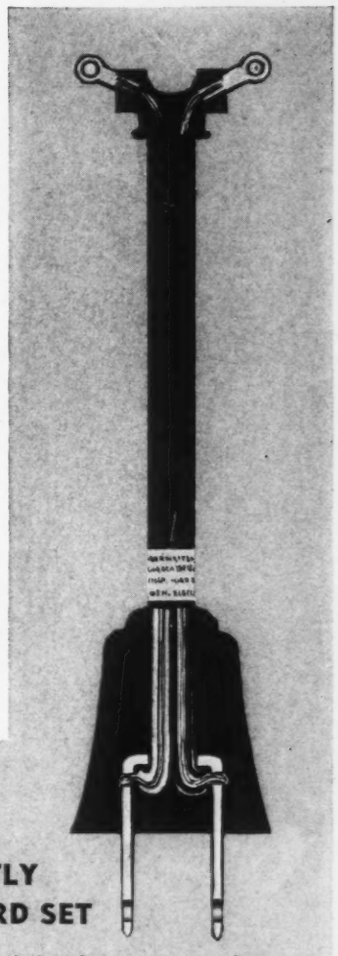
G-E CORD SETS ARE BETTER



BECAUSE

1. Only G-E Cord Sets have rubber devices molded on both ends of the cord. It is the only cord set protected by a bonded, homogeneous rubber insulation throughout . . . literally one piece of rubber from end to end.
2. Lead wires in the devices are looped and completely sealed in rubber.
3. Terminals are permanently embedded in rubber.
4. Both ends of cord are sealed. Moisture and dust are kept out forever.
5. Only cord approved by the Underwriters' Laboratories is used in G-E Cord Sets.

Sturdy G-E Rubber Connectors and Plugs are molded directly to the cord. Only G-E Cord Sets have this one-piece, molded construction. It guarantees permanence.



G-E DISCONNECTING CORD SET

This type of G-E Cord Set has many advantages. In manufacturing, there is no cord set to hinder assembly. Appliances on display look better without dangling cords. When appliance is delivered to the customer, the G-E Disconnecting Cord Set is as clean as the product itself. When not in use, the G-E Cord Set is easily detached and put away.

G-E PERMANENTLY ATTACHED CORD SET

This type of G-E Cord Set has many applications. The rubber cord protector molded on the terminal end acts as a bushing and relieves all strain on the connections within the appliance. The cord is fully protected where the bending strain is severest. There are many types of G-E All-rubber Strain Reliefs available.

G-E Accessory Equipment Engineers are available to help solve your cord set problems. For an appointment and further information, write Section Q-107, Appliance and Merchandise Department, General Electric Company, Bridgeport, Conn.

GENERAL ELECTRIC

ACCESSORY EQUIPMENT

APPLIANCE AND MERCHANDISE DEPARTMENT, GENERAL ELECTRIC COMPANY, BRIDGEPORT, CONNECTICUT

THEY HAD TO BE

WELLMAN

ELECTROPLATED

The above photograph illustrates the rapidly increasing number of tubes, for city bus, street car and tubular furniture manufacturers, plated here because the designer *specified* Wellman electro-plating—to assure sufficient coating thickness.

Many designers of parts that *must* be plated thick enough to resist constant tough wear simply specify Wellman plating—there is no need to add an "extra-thick-coating" notation.

"If it's Wellman it's well-made"

By specialization and standardization of our plating production we can give you unusually high quality at a production cost that will be of keen interest to you.

Let us send a man to give you our estimate on the plated parts you now use. Write or call us today.

The WELLMAN
Bronze and Aluminum Co.
5900 SUPERIOR AVENUE
CLEVELAND OHIO

CASTINGS • PLATED PARTS
MACHINED PARTS • BENT TUBES

drum type of brake. While the patent—No. 2,076,538—covers both wheel and transmission brakes, only the former will be considered here and is the one illustrated by *Fig.* 3.

The principle on which the device operates is that of squeezing a revolving plate between two stationary plates, floating rings of friction material preventing any metal-to-metal contact, at the same time giving a better braking effect.

The method by which the squeezing action is brought about is interesting. The flange of one of the inner movable disks is keyed to a cylindrical mounting bracket which is carried on the wheel spindle. This holds the disk from revolving, but leaves it free to move in or out. The flange of the outer disk fits over that of the inner disk on spiral threads of abrupt pitch. These threads are arranged to permit convergent movement of the disk spirally in the direction of rotation of the wheel.

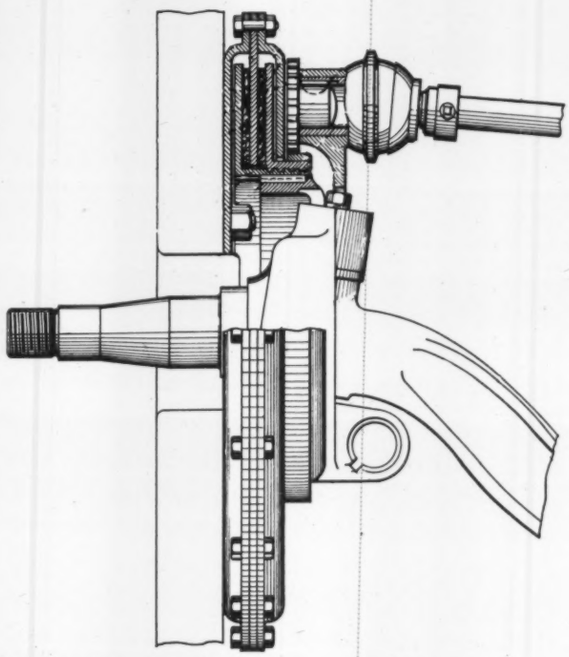
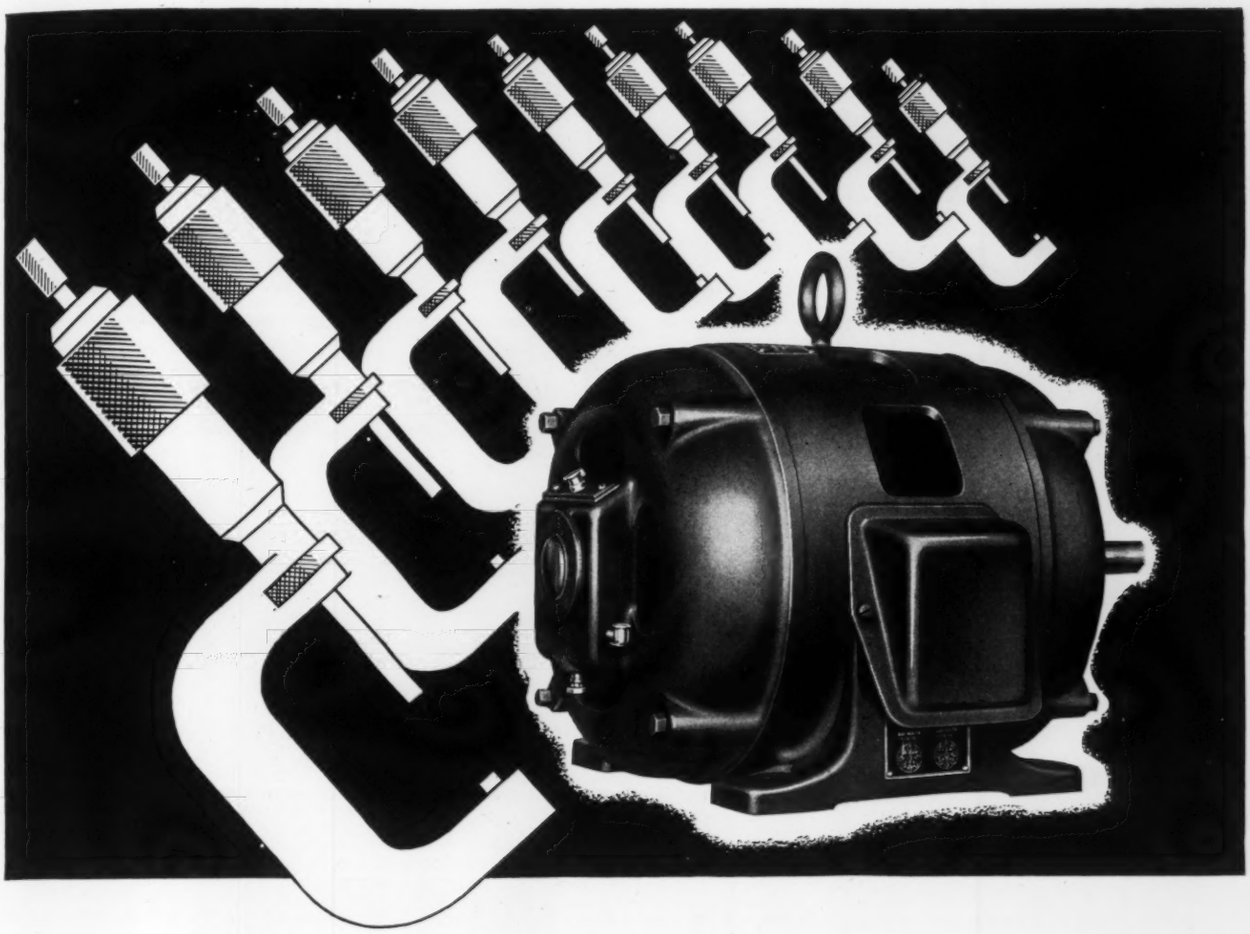


Fig. 3—*Braking is accomplished by squeezing a flat ring between floating friction rings*

A short curved section of rack is fastened to the outer periphery of the flange of the outer disk. A pinion, connected to the operating rod through a universal joint, meshes with this rack and operates the brake by "screwing" the plates together, thereby putting pressure on the revolving web between them.

The inventor points out that when the initial contact occurs between one of the friction mats and the revolving web, the effect is to continue the spiral movement of the disk carrying the rack. This tends to effect complete frictional engagement between the web and both mats—in other words, the brake becomes self-energizing.



MANY STEPS OF ACCURACY

Every Century Squirrel Cage Motor must pass many steps of controlled accuracy—from the selection and trectment of raw mate:ials to the final running tests of each individual motor.

This watchful care—backed by 34 years of knowing how to build good motors—assures you of the following advantages:

(1) They Start Quietly . . . (2) Run Quietly—No Disturbing Noises . . . (3) Are Remarkably Free from Vibration . . . (4) Keep Themselves Clean Inside . . . (5) Are Easy to Keep Clean Outside

Century engineers are prepared by long experience to give you the full benefits and economies of these important features wherever precision production is essential—where motor driven machinery and equipment is subjected to abnormal stresses, shocks and strains.

CENTURY ELECTRIC COMPANY

1806 PINE ST., ST. LOUIS, MO. • OFFICES AND STOCK POINTS IN PRINCIPAL CITIES

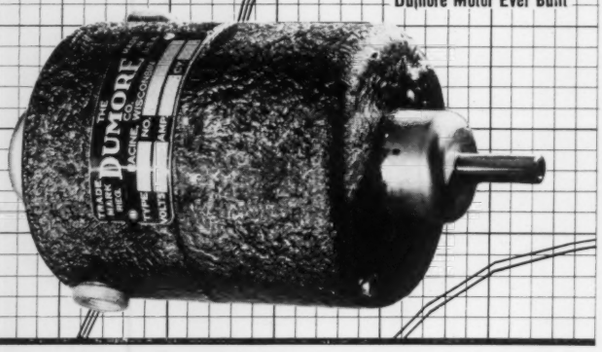
Century

SIZES UP TO 600 HORSE POWER

DESIGNERS - ENGINEERS SPECIFY DUMORE MOTORS TO ASSURE EXTRA

Power Hours

New Type H
The Lowest Priced
Dumore Motor Ever Built



Question the designer of any machine or device operated by a Dumore fractional horsepower motor. He'll tell you he wanted the *extra* hours of dependable power that he knows are built into Dumore Motors through precision manufacturing methods.

More specifically, he wanted the vibrationless running assured by Dumore *dynamic balancing;* maximum brush life obtained by *grinding commutators concentric with bearings;* centrifugal "breathing" of windings eliminated *by expansion at high speed and sealing;* 100% contact of armature leads accomplished by a *special Dumore swaging process;* each unit "run-in" to *seat its brushes properly;* and the 5-time inspection in manufacture.

Dumore Universal Motors have been selected to power a multitude of machines . . . blowers, compressors, saws, cloth cutters, hedge trimmers, drills, embossers, floor polishers, vacuum cleaners, folders, grinders, massagers, routers, hose menders, coin games, sprayers, etc., etc. Let Dumore help you solve your power problem; . . . write today for catalog and Free engineering service application blank.

THE DUMORE CO., Dept. 127-G, RACINE, WIS.

DUMORE
FRACTIONAL HORSEPOWER
MOTORS

NEW Materials and Parts

Filter Built for Backfires

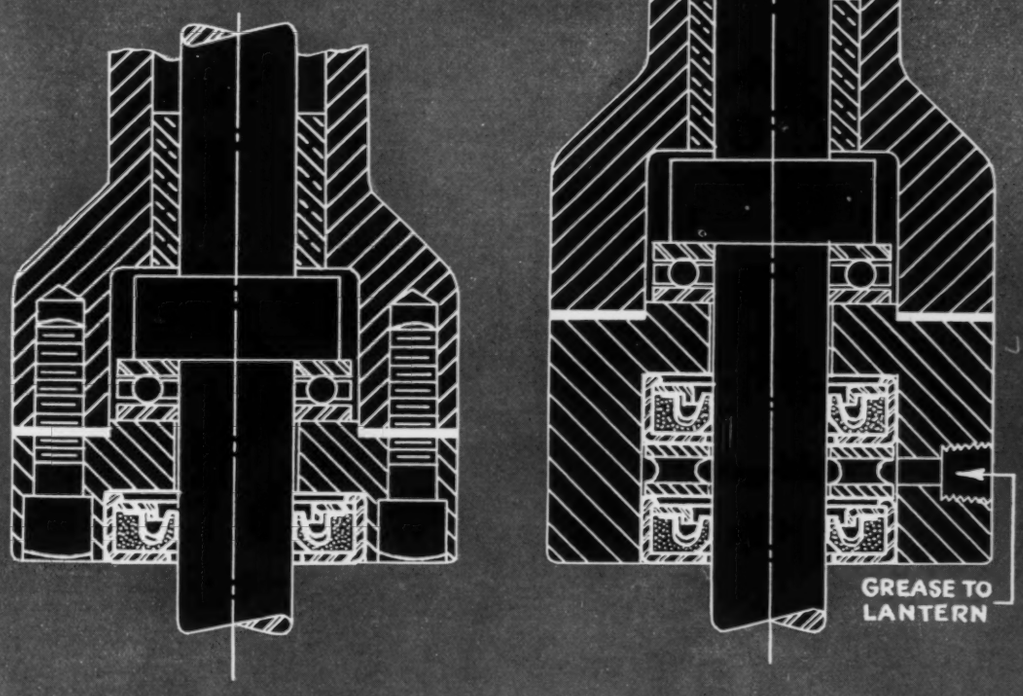
BUILT to withstand any backfires which might occur, Air-Maze Corp., 812 Huron road, Cleveland, has brought out an improved oil-bath type of air filter. Heretofore it has been necessary to place "relief" valves on the intake pipe elbows of many large engines to avoid the possibility of an explosion in the manifold. The "relief" valve is now made integrally with the filter obviating the need for any other valve in the manifold. Interior construction of the new filter follows the general Air-Maze principles. When air is drawn under the hood edge and passes down the skirt, the oil in the sump automatically washes the large circumferential filter element. The top or hood of the filter is fitted with a complete backfire valve assembly mounted on a web casting which screws on to the filter center stem. The valve rests on leakproof gaskets and is spring loaded. It is available in sizes for engines requiring from 450 to 4000 cubic feet of air per minute. Patents are pending on the design.

Spring-loaded valve in top of air filter obviates chance of damage from motor backfire

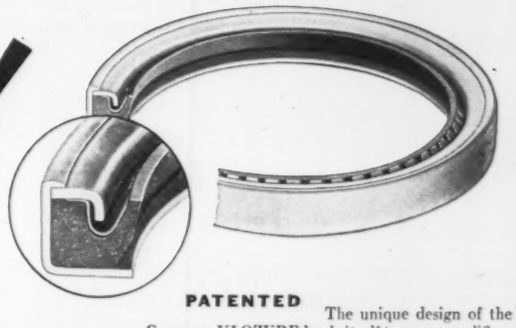
Motor Protected from Dust

PROTECTED against abrasive dust, moisture and corrosion, a new design of dual ventilated fan-cooled type CS squirrel-cage motors has been brought out by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The motor frame contains two separate sets of air ducts, one set internal and the other external. The heat exchanger principle is used in cooling. An internal fan circulates warm air through the internal duct, the walls of which are cooled by an ex-

TYPICAL APPLICATIONS OF GARLOCK KLOZURES TO VERTICAL SPINDLES ON MACHINE TOOLS



RESISTS OIL!



THE GARLOCK KLOZURE does not "soak up" oil—it *resists* oil. Also it resists the high temperatures often encountered in oil seal service. The special GARLOCK compound of which the KLOZURE sealing elements are made is dense, grainless, non-abrasive, tough and resilient. Write for new catalog.

THE GARLOCK PACKING CO., PALMYRA, N. Y.
In Canada: The Garlock Packing Company of Canada, Ltd., Montreal, Que.

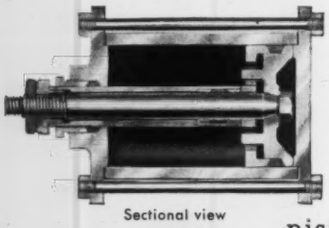
1887-1937 FIFTIETH ANNIVERSARY

PATENTED The unique design of the GARLOCK KLOZURE lends itself to many modifications to suit specific service requirements. It is extremely simple in construction—the V-shaped spreader or spring exerts a constant light pressure upon the lip of the sealing ring, pressing it into leak-proof contact with the shaft. Performance is uniform and dependable. Furnished in a complete range of sizes and for every type of oil seal application.

Garlock KLOZURE

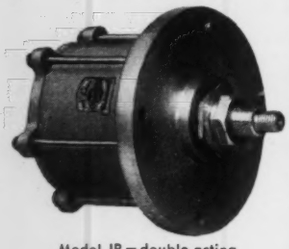
Simple Outside Adjustment *Prevents Waste* of Air Power

● Hannifin "Leak-proof" Air Cylinder construction has the simplest outside adjustment of the piston packing. Maximum utilization of air power, without leakage, can be consistently obtained, for the original high-efficiency piston seal is easily maintained throughout the entire life of the packing.

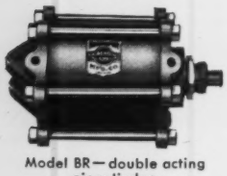


Sectional view

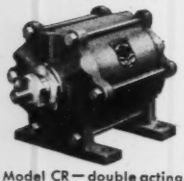
Correct adjustment of the soft, graphite treated piston packing is made, whenever required, from the outside of the cylinder without disturbing any other parts. The adjusting nut and tube are an integral assembly, locked in position on the threaded end of the piston rod. There can be no end play as the packing wears. Adjustment requires only loosening the lock nut and turning the adjusting tube.



Model JR—double acting air cylinder



Model BR—double acting air cylinder



Model CR—double acting air cylinder

Improved air cylinder performance is available for any type of use. Hannifin "Leak-proof" Air Cylinders are built in a complete range of standard types and mountings, sizes 1½ to 16 in. diameter, for any length stroke. Larger sizes built to order. Single acting and double acting types, with air cushion at either or both ends if required. Write for Bulletin 34-MD with complete specifications.

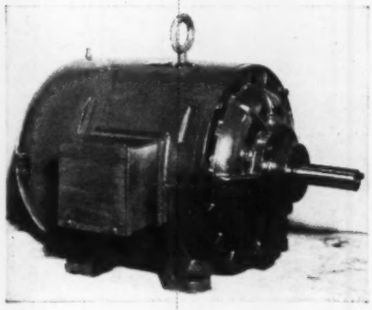
Hannifin "Pack-Less" Air Control Valves available in all types for positive control of air operated equipment.

HANNIFIN MANUFACTURING COMPANY
621-631 South Kolmar Avenue, Chicago, Illinois
Engineers • Designers • Manufacturers
Pneumatic and Hydraulic Production Tool Equipment

●

HANNIFIN
IMPROVED AIR CYLINDERS

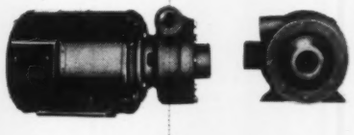
ternal fan blowing large volumes of cool air through the external duct. The housing is designed so that fresh grease enters the outside edge at the top of the bearing and excess or used grease is discharged at the bottom inner edge to the overflow sump. The motor is especially adapted for use in dusty atmospheres or those containing corrosive fumes.



Two separate sets of air ducts prevent dust or dirt entering motor

Coolant Pump Efficiency Increased

INCREASED efficiency and higher heads are possible with a coolant pump recently developed by Pioneer Engineering and Mfg. Co., 31 Melbourn avenue, Detroit. The new unit is called the Pioneer horizontal pump and is of open impeller design directly connected to an electric motor. It is ideally suited for installations on machine tools where maximum heads are essential, as in multiple or deep hole drilling or in a central reservoir serving a battery of machines. Instead of the conventional packing gland, a special mechanical seal is used at the shaft opening. This permits shortening the distance between the pump bearing and the impeller by from 4 to 10 inches. The pump operates at normal motor speeds and may be driven by single, two or three-phase motors.



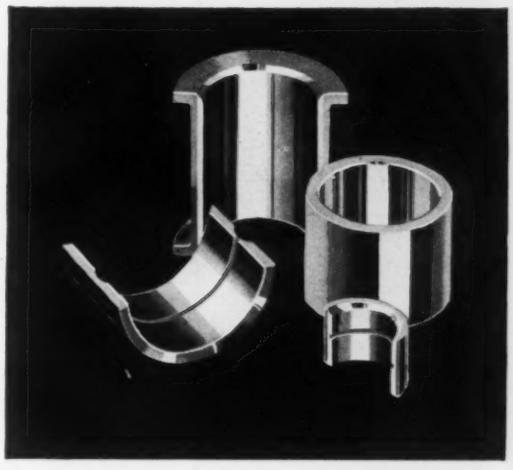
Coolant pump has special type of mechanical seal in place of conventional packing gland

Temperature Control Offered

NO GLASS tubes or liquids are used in the new model HS-4 temperature control announced recently by Burling Instrument Co., 241 Springfield avenue, Newark, N. J. Temperature settings can be readily changed by means of an adjusting screw and dial, and provision is made for locking any desired temperature setting. The control is suitable for temperatures up to 300 degrees Fahr. with an adjustable range of 150 degrees Fahr. In place of silver or mercury contacts, the HS-4 is equipped with hard Bur-

Sleeve BEARING DATA

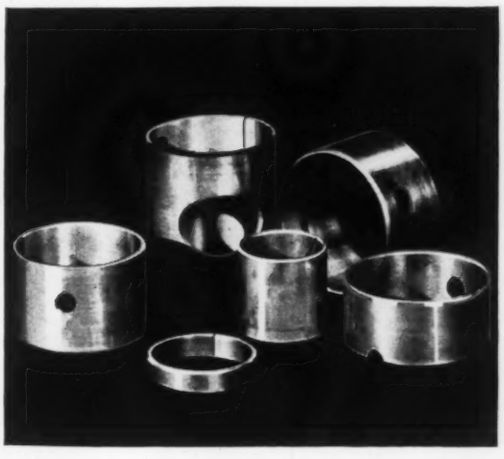
LAMINATED Sleeve Bearings



LAMINATED Bearings are used in order to obtain the highest efficiency possible in sleeve-type bearing applications. The most popular combination is either tin or lead base babbitt fused to either bronze or steel. The babbitt provides a natural low coefficient of friction plus easy conformability. The bronze or steel provides the necessary strength to the bearing.

Bronze, as a backing material, has definite advantages over steel in many applications. Excepting large production orders, Bronze is more economical. Where thrust loads must be provided for, flanges of the bronze backing material can carry such loads without lamination. With bronze, heat conductivity is higher and bearing noises are not carried as readily as steel.

Heavy duty bearings such as Deisel engines, Airplane engines, steam turbines and roll-neck bearings require steel as a backing material. In this type the babbitt is centrifugally cast into the steel shells and then the bearing is machined to prescribed limits.



LAMINATED SHEET METAL

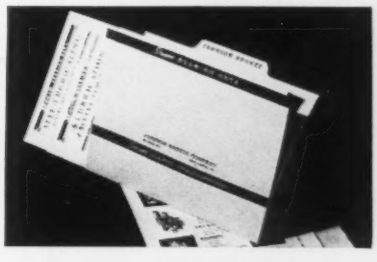
THE demand for babbitt lined bearings by the automotive industry called for a low priced backing material and the development of an economical method of manufacture. The lamination of babbitt, in a thin layer, to steel strip in a continuous process was the answer. A perfect bond of the two materials has been accomplished by exact temperature control and the prevention of oxidation of the metals at fusing temperature.

The variation possible in laminated bearings is a favorable point. The alloy of both the babbitt and the bronze can be selected in order to meet the operating conditions.

For instance, plasticity is lowered when we demand exceptional pounding resistance or resistance to wear. In laminated bearings we combine the strength of the backing material with the plastic qualities of the babbitt.

ENGINEERS . . . DESIGNERS METALLURGISTS

This data sheet is but one of several dealing with the fundamentals of sleeve bearings. Others cover such subjects as Alloys, Lubrication, Design, etc. You can secure the entire series by simply writing us on your letterhead. The complete series comes in a handy folder that will fit right into your files. Write us today. There is no obligation.



JOHNSON BRONZE COMPANY
525 SOUTH MILL STREET • NEW CASTLE, PA.
Sleeve BEARING HEADQUARTERS

U.S. Pat. No. 1,985,693

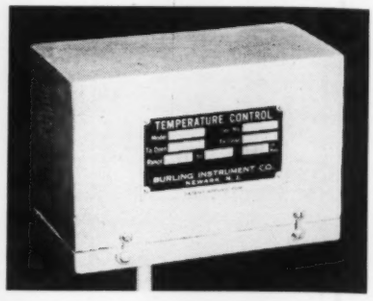
THE great load capacity of McGill *MULTIROL* Precision Bearings in limited space is revolutionizing radial bearing practice in machine design throughout the industry.

Since their introduction by McGill eight years ago, *MULTIROL* bearings have definitely proved their ability to far outrun plain bearings, and frequently other anti-friction types, in a wide variety of uses — especially under sustained heavy or intermittent shock loads. Investigate *MULTIROL* adaptability to equipment you design or build. *MULTIROL* bearings are stocked in a wide variety of standard sizes from ⅝ to 6-inch bore, single and double rows of rollers, at low, volume production prices. Corrosion and heat resisting types and special designs engineered to individual needs.

Send for Bulletin No. 37

McGILL MANUFACTURING CO.
Bearing Division, 1450 N. Lafayette St.
VALPARAISO, IND.

loid contacts which reduce wear to a minimum. The control instruments operate on 110-volts alternating



In place of silver or mercury contacts, this control unit is equipped with special alloy points

current, but relays with low voltage control circuits can be furnished.

Small Motor Developed

AVAILABLE in several different types such as ventilated, totally enclosed, sleeve and ball bearing or with worm gear speed reduction units, a 1/50 horsepower universal motor has been introduced by The Dumore Co., Racine, Wis. Known as the "H" type,

Motor is available with sleeve or ball bearings and with worm gear reduction units

it is a compact model with higher efficiency than similar motors. The standard totally enclosed "H" motor is rated at 1/50 horsepower at 6500 RPM for 30 minutes duty; the standard open model is rated at 1/50 horsepower at 5000 RPM continuous duty or 1/55 horsepower at 4000 RPM for 30 minutes duty.

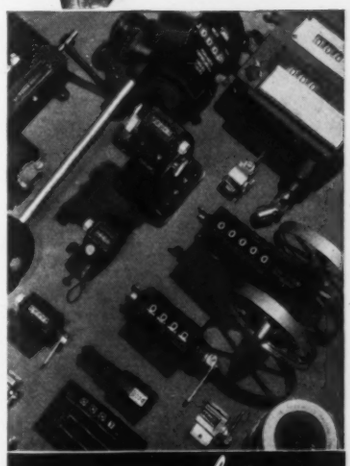
Pump Developed for Semi-Solids

UNUSUAL in that no valves are used, a positive displacement pump which is said to combine the advantages of both piston and centrifugal type pumps has been introduced by Robbins & Myers, Inc., Springfield, O. Originally developed in France and known as the Moino pump, this device is capable of handling practically any liquid which will flow through a pipe. Its application is limited only by the choice of materials used in its construction. The pumping elements

. . . *with a built-in Counting Device*

Just as valid and accurate, just as regularly accepted as the statement of a certified accountant is the record kept of a product's performance by a built-in Veeder-Root counting device. These facts-in-figures are becoming more and more necessary as clinching tools in the salesman's kit. Buyers are learning to rely on them—for they know that such performance records are the last word, the *ultimate truth* in regard to any product.

These records can be furnished in terms of operations, starts, stops, revolutions, pieces, trips, mileages, volumes, speeds, lengths, handmovements, light-flashes, etc. They *are* furnished, *daily*, on such products as business machines, elevators, trucks, typewriters, machine tools, cameras. Your product may seem to have no place or use for a built-in counting device—and yet the trained eye of a Veeder-Root engineer may spot an unsuspected opportunity. Few counter applications are obvious at first, so make certain you're not overlooking a chance to boost sales. Write.



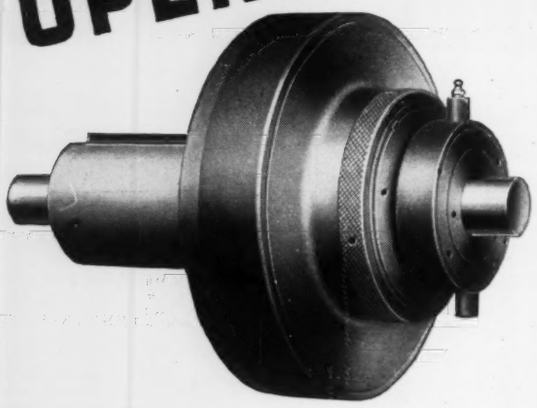
Counters for Every Purpose

VEEDER-ROOT INC.

HARTFORD, CONNECTICUT

OFFICES IN BOSTON, CHICAGO, CINCINNATI, CLEVELAND, DETROIT, GREENVILLE, S. C., LOS ANGELES, NEW YORK, PHILADELPHIA, PITTSBURGH, ST. LOUIS, SAN FRANCISCO, MONTREAL, CANADA, BUENOS AIRES, MEXICO CITY, LONDON, PARIS, TOKIO, SHANGHAI, MELBOURNE

CAN *Absorb* THE SHOCKS OF CONTINUOUS OPERATION

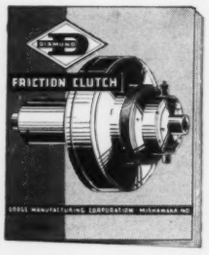


YOU CAN DEPEND ON Dodge Diamond "D" Clutches

There are probably many times when the equipment you design will be subjected to heavy shocks—when power pressures test capacities to the utmost — often a fatal spot for clutches less rugged than Dodge Diamond "D"—compact—rated to allow for 100% overload — with large friction areas — completely enclosed for workmen's safety and as full protection against dust and dirt—Dodge Diamond "D" Clutches guard your reputation for quality and dependability. Specify Dodge Diamond "D" Clutches — backed by more than half a century of leadership in the manufacture of power transmission equipment.

Write for Catalog No. A-200.

DODGE MANUFACTURING CORP.
Mishawaka, Indiana, U.S.A.

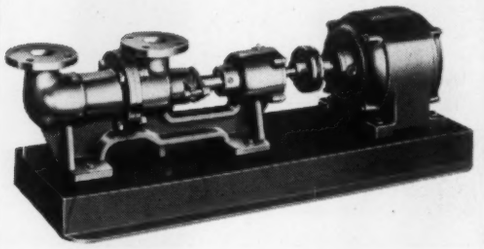


THE Right DRIVE FOR EVERY JOB

DODGE
MISHAWAKA

THERE IS ADDED VALUE IN THE NAME DODGE

consist of one stationary part, the stator, and one rotating part, the rotor assembly. The stator is in the form of a cylindrical lining which has an internal form of a double threaded helix, and the rotor is in the form of a single threaded helix, such that it meshes with, and turns in, the helix of the stator. In simple form, the efficient maximum delivery head is from 150 to 200 feet of water. By combining two or



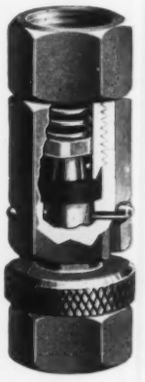
Rotor and stator may be lined with rubber as protection against corrosion

more stators and rotors in the line of flow, 500 to 800 feet of discharge head can be obtained. Solids with diameters up to approximately one-half the clearance space between helix and rotor may be pumped. Up to one-fourth volume of sand to water is readily pumped, and larger ratios may be handled. Five sizes are being designed and placed in production which will constitute the standard line for the present.

Larger Air Coupler Offered

FOOLPROOF construction is built into a new ½-inch air coupler placed on the market by The Ritex Co., Berkeley, Calif. Containing an automatic shut-off valve, the coupler-gives positive shut off when plug is removed. Safety lock nut prevents any chance

Automatic shut-off valve prevents escape of air when plug connection is removed



of coupling coming apart when in use. An ordinary rubber washer such as is used in a Schrader tire air chuck can be used to replace the original one if it wears

(*Continued on Page* 76)

TWO GREAT PERFORMERS THAT HELP *Cut* Depreciation Costs TO THE CORE

By adding years to the life of your motors and machines, Morse couplings help cut your depreciation costs to the core. Morse builds two types of couplings. *Standard* (all-steel) consists of two facing, hardened-steel sprockets wrapped in a silent chain which is the flexing medium. The entire assembly is enclosed in a grease-packed dust-proof case. *MORFLEX* couplings use rubber as the flexing medium. They are furnished with or without cover, and require no lubrication. Both Standard and Morflex couplings are easy to connect and disconnect. For more information, telephone the Morse Coupling engineer in your territory or write to us here in Ithaca, today.

Right: MORFLEX rubber-bushing-type coupling without cover. Center: Morse Standard Coupling on the job. Above: MORSE STANDARD chain and sprocket type coupling without case.

MORSE
SILENT CHAINS

MORSE
ROLLER CHAINS

MORSE
KELPO CLUTCHES

MORSE FLEXIBLE COUPLINGS

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

IMAGINE STOPPING A NEWSPAPER PRESS TO *"Oil Around!"*

THERE is no place for hit-or-miss greasing or oiling in modern, high-speed printing plants. Presses must not be stopped—neither can they be properly lubricated manually "on the fly." But with the Farval Centralized System of Lubrication, every bearing on the press is adequately supplied *at all times*—no matter how long the "run."

The Farval Centralized System of Lubrication is a mechanical method of delivering clean lubricant from a central station under high pressure to a group of bearings, in exact, measured quantities. Operation is constant and positive, regardless of the number of bearings in the system, *and not a bearing is missed.*

Correct lubrication is no doubt an equally important factor in the machines *you* design, and a Farval System will greatly enhance their usefulness to your customers. A Farval Engineer will bring you full information. The Farval Corporation, 3265 East 80th Street, Cleveland, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Cleveland, Manufacturers of Automotive and Industrial Worm Gearing.

FARVAL

CENTRALIZED SYSTEM OF LUBRICATION

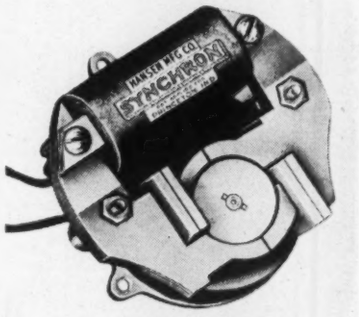
Special Delivery to Every Bearing

(*Continued from Page 72*)

out. Besides the ½-inch coupler, the company makes a ¼-inch model.

Synchronous Motor Fits Tiny Space

SELF-STARTING and only 15/16-inch thick, a synchronous motor recently brought out by Hansen Mfg. Co., Princeton, Ind. has a wide variety of applications. Model AA operates at 3600 RPM on 110 volts alternating current, 60 cycles and can be mounted in a 2⅝ inch circular space. A similar model has been used in electric clocks, operating pin-

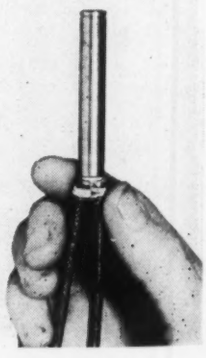


Double bearing arrangement gives exceptional rotor rigidity in this small motor

ball machines, timing X-ray equipment and other applications where a small reliable motor is needed. A double bearing arrangement is provided in the new model which reduces wear and gives the rotor more rigidity. Reduction gears are sealed in a bath of oil in a die-cast housing which eliminates the need for lubrication. The housing is equipped with four lugs which permit the motors to be mounted either from the front or rear.

Heat "Spot" Possible with Element

WHERE a "spot" of heat is required within a limited space, a new small cartridge-type heat-



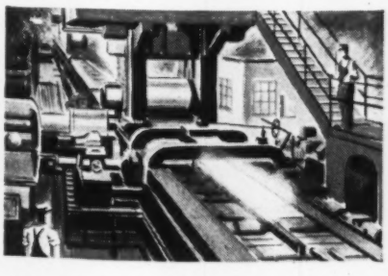
Tiny heating element is made in brass case

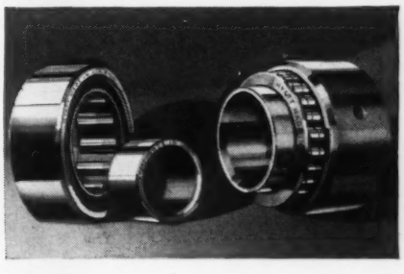
ing unit, recently announced by General Electric Co., Schenectady, N. Y., offers many advantages. The new

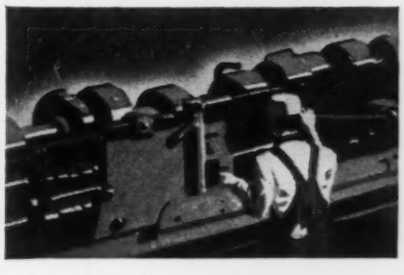
Look into the Hyatt laboratories. See endurance tests running day and night, simulating every sort of normal and abnormal bearing operating conditions. Speeds, shocks, loads, temperature, wear, and care—duplicated and studied in an endeavor to add more priceless operating hours to the already acknowledged long-life span of Hyatt Roller Bearings.

Painstaking research, incessantly carried on by Hyatt engineers, to improve design, manufacturing materials, and application methods. No wonder these enduring bearings built by Hyatt craftsmen for motor cars, farm machinery and industrial equipment serve so well. Hyatt Bearings Division, General Motors Corporation, P. O. Box 476, Newark, N. J.

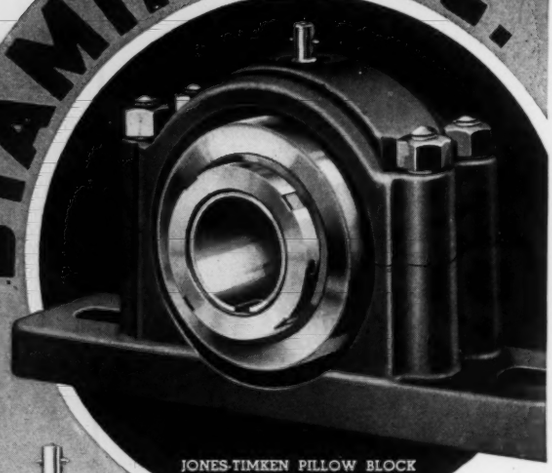
HYATT
ROLLER BEARINGS



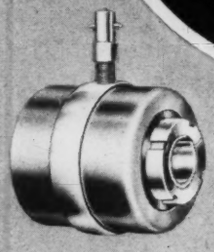




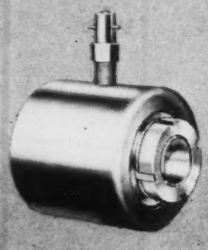
STAMINA, INC.



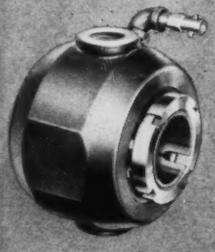
JONES-TIMKEN PILLOW BLOCK
Shaft sizes ⅞" to 9"



SPHERICAL BEARING



CYLINDRICAL BEARING



HANGER BEARING
Shaft sizes 1⅜" to 3½"

JONES roller bearing pillow blocks and bearing units are built to solve those tough drive problems where stamina and the ability to "take it" are mighty important.

One look at these bearings will convince you that they belong to the Jones drive family. They have that sturdy look and years of maintenance records have proved how they stand up to the job.

These bearing units are practical . . . double row Timken roller bearings are locked firmly to the shaft by means of a tapered split steel adaptor and clamp nut . . . an effective seal retains lubricant and prevents the admission of dust and foreign matter . . . they are easily removed from the shaft.

The Jones organization will be pleased to give you complete details showing range of sizes built, dimensions, construction specifications and prices. Just ask for Bulletin No. 56.

W. A. JONES FOUNDRY & MACHINE CO.
4413 Roosevelt Road, Chicago, Ill.

Since 1890
Jones

HERRINGBONE — WORM — SPUR — GEAR SPEED REDUCERS
CUT AND MOLDED TOOTH GEARS — V-BELT SHEAVES
ANTI-FRICTION PILLOW BLOCKS — PULLEYS
FRICTION CLUTCHES AND TRANSMISSION APPLIANCES

unit, the smallest of the General Electric line, is only ⅜ inch in diameter and is manufactured with a brass sheath for maximum operating temperature of 750 degrees Fahr. It is convenient for built-in applications and can be quickly installed. Available in ratings of 30, 75, and 90 watts at 115 or 230 volts, alternating or direct current.

Furnace Control Serves Two Needs

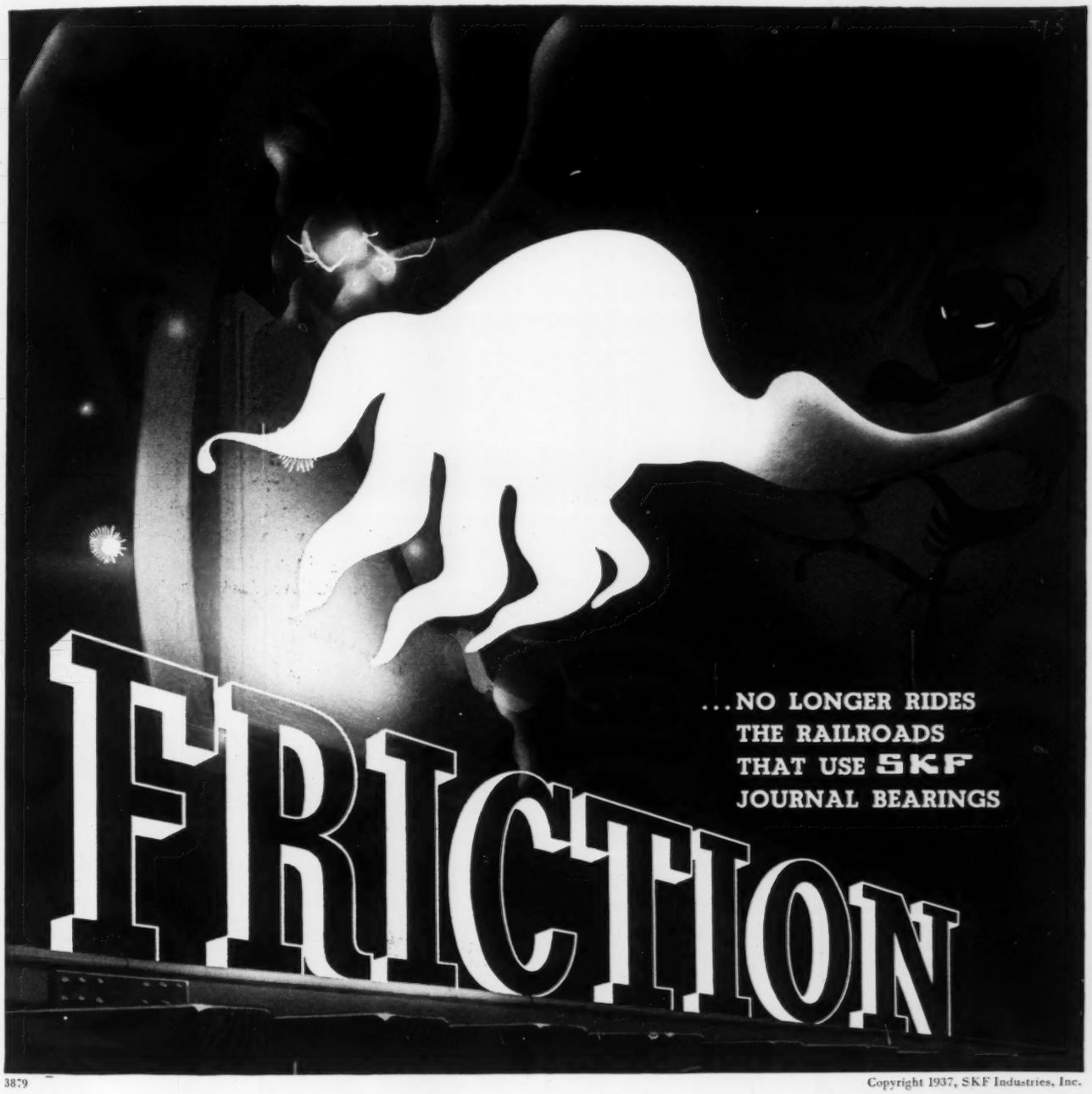
DOUBLE adjustments for both fan and limit switch settings are provided in the type M-80 combination fan and temperature control for warm air furnaces brought out by The Mercoid Corp., 4201 Belmont avenue, Chicago. Adjustments permit individual setting of both the high and low operating

Individual adjustments permit separate settings of high and low operating

points. A visible dial is provided which is calibrated from 50 to 300 degrees Fahr. The Mercoid sealed mercury switch is the operating medium in the new control unit. The control dial automatically regulates the tipping of the mercury switches thus turning off or on the fan or blower at the desired temperature. A flange facilitates installation on the furnace hood as it may be adjusted for any angle between 30 and 90 degrees.

Motor Protector Uses Judgment

BUILT to use "judgment" in protecting motors against overloads, a new protector for fractional horsepower motors, the "Motor-Cop" is built by Micro Switch Corp., Freeport, Ill. Unlike conventional type protectors which open the circuit as soon as the current exceeds 140 per cent of full load rating, the new Motor-Cop does not shut off the current until an unsafe temperature is reached. In tests it has been found that a motor will operate as much as 70 minutes under overload before an unsafe temperature causes the protector to shut off the current. In addition to the



3879

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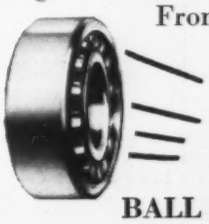
REMEMBER the hot box era of railroading . . . when Friction at work in journal boxes brought train after train to a halt and turned time tables into mere scraps of paper?

Those days have gone forever on the railroads that are equipped with SKF Journal Bearings. SKF actually made Friction get off and walk!

SKF tackled the problem of steam railway journal friction in its world famous laboratories twenty years ago. At that time no bearing in all the world had ever been able to solve it.

So SKF created a new type of bearing, the spherical Roller Bearing, sturdy enough to take shocks that make hillsides tremble, designed to stand up for years without offering trouble, without demanding adjustment, without even showing signs of appreciable wear.

Today, there are SKF spherical Journal Bearings still in operation after 1,500,000 miles of service. And more of them are in use on the railroads of the world than all other makes of anti-friction bearings combined. SKF INDUSTRIES, INC., Front St. & Erie Ave., Phila., Pa.



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IF LOWER COSTS FOR QUALITY BEARINGS INTEREST YOU . . INVESTIGATE . . .

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have for more than a third of a century served machinery and equipment manufacturers with unfailing and uniform performance . . . Precision manufacture, friction eliminating tolerances, and maximum built-in strength assure trouble-free operation under all conditions for which they are designed . . . A seventy-page reference book illustrating standard bearings and giving valuable bearing data is available . . . Write for your copy today.

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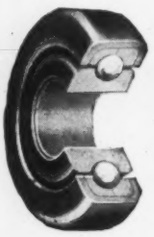
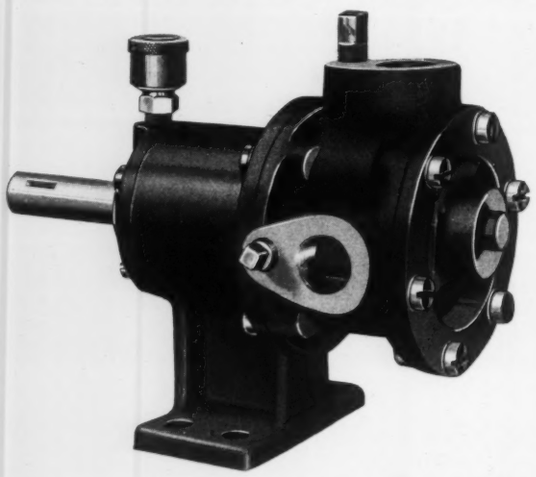




Coolant Pumps!

The Viking Coolant Pump is designed with many special features. Features that improve its adaptation to the special purpose of supplying the cooling liquid to metal being processed by machine. We've got a lot to tell you about this pump. We suggest that you write for bulletins, today.

VIKING PUMP COMPANY
CEDAR FALLS—IOWA

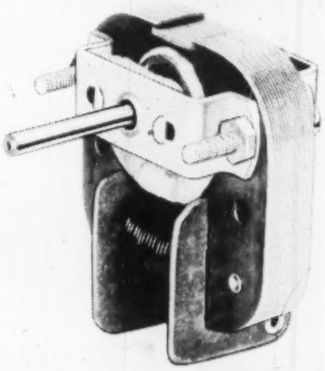
protection against excessive temperatures on overloads, a separate bimetal element is actuated by current alone to open the circuit promptly in case of a

Motor temperature actuates safety switch

stalled rotor. The new protector is small enough to mount inside the end bracket of standard motors from ⅛ to one horsepower.

Minute Motor Has Many Uses

INTENDED for radio tuning use and applications requiring motive power in small amounts, a motor of split-phase design has been brought out by Delco Appliance Division, General Motors Sales Corp., Rochester, N. Y. The motor is approximately 3 inches high and 2½ inches wide. Armature is built to obviate any dead spots and gives exceptionally high starting torque. Other features include: Double-



Split-phase motor is three inches high and 2½ inches wide

run enamel-wire field coil, laminated stator and rotor, self-aligning composition bearings and optional reversibility. At 2500 RPM the motor gives .002 horsepower and operates on voltages from 6 to 110 and 25, 50 or 60 cycles.

New Alloy Combats Corrosion

PRODUCED primarily for service in equipment handling hydrochloric and other corrosive acids, a new alloy known as "Hastelloy B" is now being offered. It was developed by Haynes Stellite Co. and Union Carbide & Carbon Research Laboratories, Inc., 205 East 42nd street, New York. The new alloy is composed of nickel, molybdenum and iron. Its physical properties are comparable to those of a good grade of alloy steel, tensile strength being about 135,000 to 140,000 pounds per square inch. The hardness and strength of Hastelloy B, although making it somewhat hard to forge, are of good advantage in other ways,

for the alloy is unusually strong at high temperatures. Important applications of the metal are for agitator units, heating and cooling coils, pumps, valves, pipes and fittings.

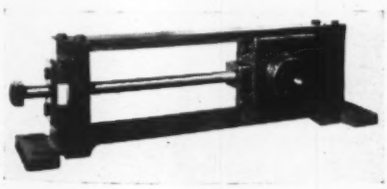
Pump Motors Have Wider Range

CHARACTERISTICS and design of motors available for driving rotary geared motorpumps made by Brown & Sharpe Mfg. Co., Providence, R. I., have recently been changed. Pumps Nos. 101, 102 and 103 are now made to run in one direction only, the direction being determined by the side of the pump on which the discharge is located. These pumps are now available with three-phase motors both in 220 and 440 volts, 60 cycles. Similarly, No. 204 centrifugal motorpump is now furnished with three-phase, 50 cycle, 220 volt motor turning at 1425 RPM.

Pumps are now driven by three-phase motors which run in only one direction

Bearing Take-Up Easily Adjusted

STANDARD antifriction or babbitt bearings are interchangeable on a new type of take-up bearing designed by The Smith Power Transmission Co., Cleveland. The adjusting screw and nut are replaceable



Only necessary to remove plate, take out key and pull out screw to make bearing adjustments

Bill finds the RIGHT paper (Thanks to the Bruning Sample Book!)
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loading anti-friction thrust bearings

LAMINUM SHIMS not only provide the precision required for loading this anti-friction bearing in the original assembly . . . the shim makes possible the same accuracy in adjustments from time to time for the life of the bearing . . . without filing or machining! You simply P-E-E-L one or more laminations at a time from the solid laminated brass shim.

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BRAD FOOTE'S NEW REDUCER MANUAL IS NOW READY

Send For Your Copy

The Brad Foote reducer manual has been scientifically compiled, making it easy to obtain ratings and dimensions at a glance. The book is especially useful in obtaining new thoughts in the power transmission field and will be definitely helpful in solving your problems for power transmission.

FOOTE GEAR WORKS, INC.
1301-D S. Cicero Avenue Cicero, Illinois

without the need of removing bearing or frame. For removing take-up screw and nut to replace worn parts, it is only necessary to remove plate on adjusting end of frame, remove key in bearing frame which retains screw and pull out screw with nut. Adjustments may be quickly made in the field without the need for replacing individual parts which wear rapidly.

Pushbutton Easily Operated

PROVIDED with a large "mushroom" head, an improved pushbutton station has been developed by General Electric Co., Schenectady, N. Y. for applications where the operator wears heavy gloves or asbestos mittens. The mushroom head projects from the front of the button, making it an easy matter for the operator to slap the button when conditions require him to make a rapid, positive shutdown of the machine. The new pushbutton is of the same general construction as standard G.E. heavy-duty pushbutton stations, except that in the new station the molded "stop" button to which the mushroom head is fitted is approximately ½ inch longer.

Projecting head on pushbutton makes it easy for gloved operator to shut off power

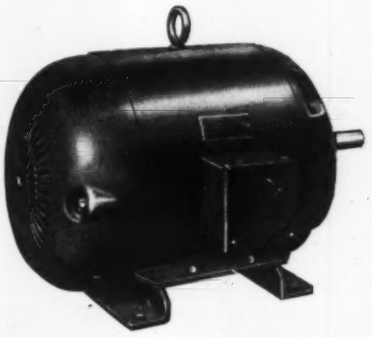
Addition Made to Coupling Line

AN ADDITION to the line of Model S-2 flexible couplings, having a maximum bore of two inches and a horsepower rating of 12½ at 100 RPM, has been announced by Ajax Flexible Coupling Co., Westfield, N. Y. This new coupling has a torque rating of 660 foot-pounds and a maximum RPM of 7500. Overall diameter is 6⅛ inches. All Model S-2 couplings are of rubber-cushioned design and stocked with bores from 1¼ inches to two inches.

Motor Is Totally Enclosed

TOTALLY enclosed, fan cooled, the type CP motor introduced by Wagner Electric Corp., St. Louis, Mo., is ideally suited for operation in atmospheres

laden with abrasive dust, in corrosive gases and extreme dampness. The motor consists of a skeleton type stator, deeply grooved on the outside to increase radiation. An external blower is mounted on the front end to direct cooling air around the front endplate, over the corrugated surfaces and through a baffled back endplate down over the bearing. The

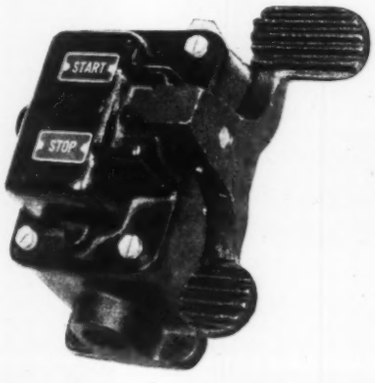


Motor shaft has machined fillets at each change of diameter to avoid stress concentrations

shaft is made of special alloy steel and has machined fillets at every change of diameter to prevent concentrated stress. Ball bearings are of the cartridge type, and of the same diameter on both ends to permit double shaft extensions of the same diameter. Feet of the motor are welded to the frame and are made of high tensile strength steel.

Foot-Operated Motor Controller

FOR installations where the operator must have both hands free while starting or stopping his machine, General Electric Co., Schenectady, N. Y., has developed a treadle-operated, watertight pushbutton station (type CR2940-2A18). The enclosing parts of



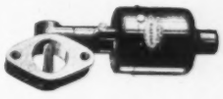
Packing gland on treadle shaft prevents moisture entering controller

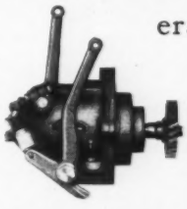
the control, case and cover, are made of cast iron, and a cast-iron treadle is built-in to the cover. To eliminate the possibility of moisture entering the station, a packing gland is fitted on the treadle shaft where it enters the case. The shaft is also provided with a spring which causes the pedal to return automatically to a neutral position.

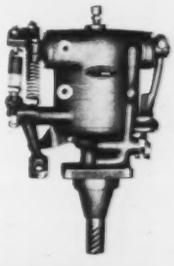
POWER CONTROL
perfected by
PIERCE

•

Through twenty-five years of engineering experience and governor research, the Pierce Governor Company has developed a line of governors that completely covers every industrial application. • *The Pierce Engineering Staff* co-operates with engine designers and builders, and all manufacturers of engine-driven equipment in the development of new or unusual types of governors to meet today's needs. • Correct in principle, painstakingly built to a minimum tolerance, Pierce Governors are recognized as standard the world over. • Put your governor problems up to Pierce—write for new complete catalog just off the press.







PIERCE GOVERNOR COMPANY
109 OHIO AVE., ANDERSON, INDIANA

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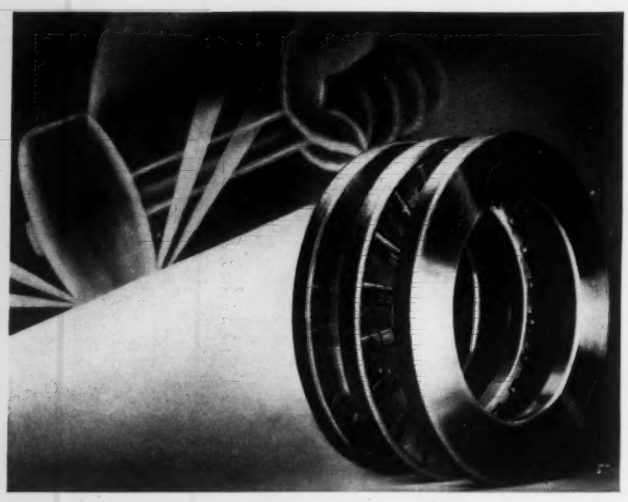
STANDARD SINCE 1913



HEAVY IMPACTS AT HIGH SPEED

When a leading manufacturer of pulverizing equipment had to find bearings that would carry tremendous loads, withstand proportionate impacts delivered at high frequency, and at the same time operate at abnormally high speeds for bearings of size necessarily involved, he came to ROLLWAY.

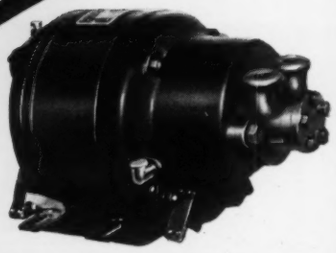
The applications were radical and if successful would immediately decrease the limitations normally placed on roller bearing performance.

Intensive study by ROLLWAY engineers yielded recommendations that have given first-class, trouble-free performance.

Perhaps we can help solve some of your tough problems—The first step is to write for a ROLLWAY Analysis.

ROLLWAY BEARING CO. INC., SYRACUSE, N. Y.

BUILD the PUMP INTO Your Machine



TUTHILL PUMPS FOR THE PURPOSE

It's sound engineering to build the pump into your machine. That's why Tuthill is working hand in hand with machine designers and manufacturers, furnishing small industrial pumps for coolant, lubrication and hydraulic mechanisms, which can be incorporated directly into the design of the machine.

Write FOR COMPLETE INFORMATION TODAY

TUTHILL PUMP COMPANY
941 EAST NINETY-FIFTH ST., CHICAGO, ILLINOIS

For information on pump illustrated, send for Tuthill Small Industrial Pump Bulletin

Viewpoints

(*Continued from Page* 52)

book will be ready for publication in the Fall. Many interesting and favorable comments on the appearance of the articles in book form have been received.

Polygonal Parts Serve Designer

To the Editor:

THERE are endless uses of polygonal forms in design which solve specific problems for the designer. These applications are usually in obscure instances, however, and the average engineer never comes in contact with them.

One interesting application is the use of cams of this type for the purpose of reproducing such forms on work-pieces. In the production of many ornate furniture legs and other furniture pieces which have an octagonal or hexagonal section plus sweeping curves lengthwise, the automatic turning lathe is used. A gang of cutterheads is mounted on a shaft which, in turn, is in a trunnioned mounting in line with and behind the axial line of the work. The work itself is mounted between a pair of centers which revolve slowly, though the gang of cutterheads turns at high speed. The problem is to swing the cutterhead shaft to and from the work as the latter revolves. The cutterhead shaft must approach the work at such a rate as to generate an octagonal, hexagonal, oval or other form on the work, as predetermined.

To do this, a polygonal, oval or other type of cam is mounted at the end of the work in connection with one of the centers which supports it. A contact shoe is arranged upon the trunnioned mounting frame of the cutterhead shaft in line with, and bearing against the cam. Spring action is provided to force the two machine elements to approach each other, but they are held at a given point at every instant by the cam and shoe. Thus, as the work turns slowly, the gang of cutterheads swings back and forth to generate the desired section on the work.

There is little relation between special lathes and steam traps, but another interesting use of polygonal forms is illustrated by the latter. In a steam trap of the inverted bucket type, the intake tube forming the stem on which the sliding element is actuated, is hexagonal in form. The reduction of friction is considerable with a round inside diameter sliding on the outer corners of a hexagonal form.

There are other instances in which the principle could be advantageously applied in modified form. No mechanical law prevents turning or grinding the outer corners of a slightly oversize hexagonal shaft to operate with a combined sliding and turning action in the common inside diameter tube, or possibly to operate on a strictly turning or sliding basis.

— J. E. H.
Peoria, Ill.

MANUFACTURERS' PUBLICATIONS

ALLOYS (IRON)—Pumps, valves, heat exchangers and other parts made of corrosion-resistant metal are described in a general catalog issued by The Duriron Co., Inc., Dayton, O.

ALLOYS (NICKEL)—Applications of Monel metal in the gyro-pilot, in pumps, sewage disposal equipment and for fasteners are described in Vol. 1, No. 2, of "Nickelsworth" published by the International Nickel Co., Inc., 67 Wall street, New York.

ALLOYS (STEEL)—A new metallurgical handbook of 189 pages giving a complete review and reference source for the chemical composition, physical properties, heat treatment and recommended applications and fabricating procedure of all irons and steels with vanadium as an alloying agent has been published by Vanadium Corp. of America, 420 Lexington avenue, New York.

ALLOYS (STEEL)—Methods of welding Enduro stainless steel, are described in a 20-page booklet issued by the Republic Steel Corp., Cleveland, O. Examples are shown of parts and structures that have been successfully welded of this steel.

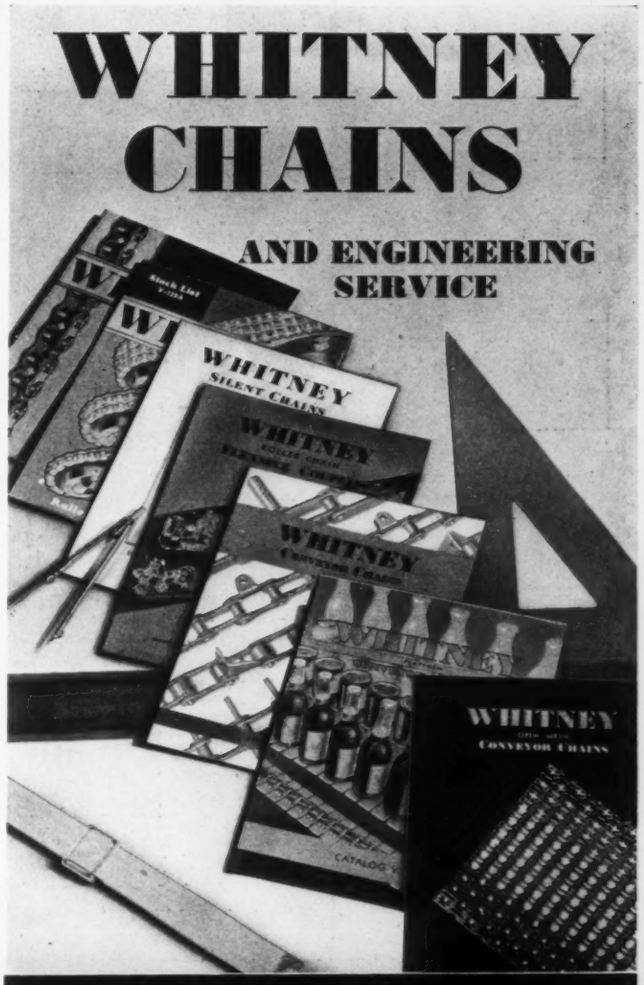
BEARINGS—Specifications and prices of standard bronze bearings manufactured by the Buckeye Brass & Mfg. Co., 6410 Hawthorne avenue, Cleveland, are covered in catalog 137 issued by the company.

BEARINGS—Volume 1 of the eleventh edition of the New Departure handbook, prepared by New Departure, Division of General Motors, Bristol, Conn., contains complete specifications on standard types of ball bearings made by the company. Load computation data and formulas will be covered in volume 2 to be available shortly.

CONTROLS (ELECTRICAL)—Various types of automatic Mark-Time switches for stopping current after a predetermined period are described in a small booklet issued by M. H. Rhodes Inc., Rockefeller Center, New York.

CLUTCHES—In a booklet issued by Rockford Drilling Machine Division, Borg-Warner Corp., 113 Catherine street, Rockford, Ill., illustrations are shown of a variety of Pullmore clutch applications. Specifications of the clutches are included in the booklet.

COUPLINGS—Bulletin 4100 superseding bulletins 181



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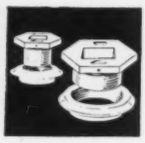

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and 182 gives specifications, applications and construction of Steelflex couplings, manufactured by The Falk Corp., Milwaukee.

ENGINEERING DEPARTMENT—Decimal equivalent and tap drill size charts, covered with cellophane, showing nominal and decimal dimensions of all standard drills, one inch and under, arranged in order of sizes have been prepared by Whitman & Barnes, Inc., Detroit.

ENGINEERING DEPARTMENT—Vibration study and other applications of the Neobeam oscilloscope are the subjects of a booklet prepared by Sundt Engineering Co., 4238 Lincoln avenue, Chicago. Other instruments made by the company are described.

ENGINEERING DEPARTMENT—Description of the new Revolute 3-H blueprinting machine is given in a pamphlet by Paragon-Revolute Corp., Rochester, N. Y.

FINISHES—Stainless steel snap-on moldings for use in industrial design are covered in a 12-page illustrated booklet prepared by Pyramid Metals Co., 455 North Oakley boulevard, Chicago. Method of attaching the moldings is also shown.

INSTRUMENTS—Catalog 15-C of The Brown Instrument Co., Philadelphia, covers the complete line of millivoltmeter pyrometers made by the company. It also describes a new moisture-proof rotary switch, control relays, valve mechanisms, thermocouples and accessories.

INSTRUMENTS—"The Technique of Noise Measurement" is the title of bulletin 20 issued by General Radio Co., Cambridge, Mass., and explains the use of the sound level meter and how to make sound measurements.

INSTRUMENTS—Detachable instruments for outdoor and indoor service are described in catalog section 43-600 of Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. In addition to a price list, this ten-page pamphlet includes outline dimensions, application data, testing facilities, and wiring diagrams.

INSTRUMENTS—New developments including the high speed photoelectrically balanced multipoint recorder are contained in catalog 1101C recently issued by C. J. Tagliabue Mfg. Co., Park and Nostrand avenues, Brooklyn, N. Y. Photographs show the working parts of the instruments.

LUBRICATION AND LUBRICATING EQUIPMENT—Technical Bulletin No. 270.1 of the Acheson Colloids Corp., Port Huron, Mich., explains by text and line drawings the utility of graphite surfaces. Other uses of graphite than for lubrication are described.

LUBRICATION AND LUBRICATING EQUIPMENT—Specifications and descriptions of the many parts

which make up the Alemite line are given in an illustrated booklet of Alemite, Division of Stewart-Warner Corp., Chicago.

PACKING AND PACKING GLANDS—A booklet of 20 illustrated pages containing information on oil seals, types of installations and a complete listing of sizes has been issued by Victor Manufacturing & Gasket Co., 5752 Roosevelt Road, Chicago. Title of the booklet is "Victoprene."

PACKING AND PACKING GLANDS—Commemorating the 50th anniversary of the Goetze Gasket & Packing Co., Inc., New Brunswick, N. J., the company has published a booklet describing the plant and processes in the manufacture of gaskets.

PACKING GLANDS AND PACKING—Complete data on various kinds of packing is contained in a 112-page book issued by United States Rubber Co., 1790 Broadway, New York. An index of new and old parts numbers is included in the book.

PLASTICS—"The Story of Molded Plastics" is the title of a 40-page booklet released by Chicago Molded Products Corp., 2145-58 Walnut street, Chicago, covering the important essentials of producing plastic products. A listing and illustrations of standard molded products are given in the booklet.

SPROCKETS—Bulletin 60 released by Baldwin-Duckworth Chain Corp., Springfield, Mass., covers specifications and prices of standard hub sprockets for single, double and triple roller chains.

TUBING—A comprehensive booklet giving applications, specifications and general information on seamless steel tubing has been prepared by the Pittsburgh Steel Co., Pittsburgh, Pa. Beam and other formulas are included in the booklet.

TUBING—Bulletin SS-3 of the American Brass Co., American Metal Hose branch, Waterbury, Conn., illustrates typical installations of flexible tubing, describes its construction and gives general specifications.

UNIONS—Uses and properties of the new Dualsteel union are described in a leaflet released by Rockwood Sprinkler Co., Union Division, Worcester, Mass. The union is available in a wide variety of sizes and with silicon or stainless steel seats.

Research Publications

Alignment Charts, Their Construction and Use, By Dr. Paul N.Lehoczky, department of Industrial Engineering, Ohio State University. Purpose of the book is to teach the reader to construct a simple type of chart for any type of equation, no matter how involved, and to do this without the necessity of a theoretical background other than algebra. The method employed is called "kitchen recipe" because it presents the material in that fashion without going into the theory.

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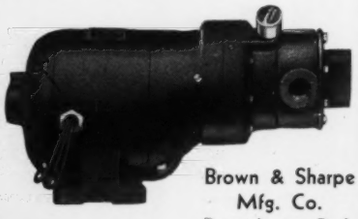

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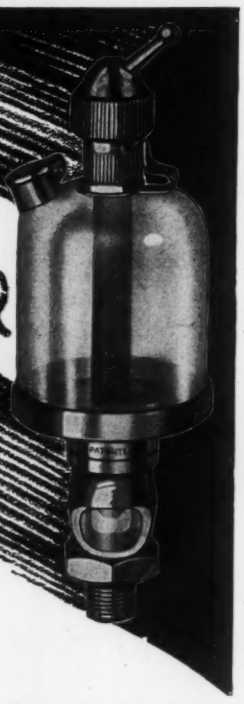

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Oilless Bushings Reduce Maintenance

(*Continued from Page* 44)

ing into use again after a dormant period of 20 years is a leaded bronze bearing. Originally known as Kelly metal this bronze contains from 18 to 35 per cent lead which permits extended operation without oil or grease under comparatively heavy loads. The makers claim that this bearing has high resistance to shock and impact and is suitable for high-speed service.

For extremely heavy duty operation the most success has been obtained with a solid bronze bushing with grooves cast or machined on the inner surface into which graphite is pressed. *Fig.* 4 shows a bushing of this type with a part of the outer surface milled out to provide an oil reservoir. This type of bearing will operate almost indefinitely without oil in the reservoir or periodic lubrication; oil added simply prolongs life, decreases noise and wear and permits the carrying of greater loads at higher shaft speeds. Bearings of this type should have a thickness of at least 3/16 of an inch to permit cutting of grooves deep enough to hold the graphite. Where a thinner walled bushing is needed, a metal strip roughened and filled with graphite particles is rolled into a bushing. This latter type is widely used for small machines where space and weight are factors to be considered.

Rubber Bearing Water Lubricated

Certain machine applications require an oilless bearing that sand, grit or other abrasive particles will not damage. Developed originally for marine use, a water-lubricated rubber bearing is available now which can be used in water turbines and large pumps. *Fig.* 5 shows this type applied to the propeller shaft bearing of a boat. Grooves are molded in this bearing which permit a constant flow of water between it and the journal. Sand, if it enters the bearing, is merely forced into the rubber without scoring the shaft and finally works out and is washed away. The life of this type is said to be several times that of metallic bearings used for marine installations. Another application of a rubber cutless bearing is shown in *Fig.* 6. The nine-inch shaft of this large drainage pump is supported by a rubber bearing.

Oilless or self-lubricating bearings do not have the low coefficient of friction that a well-oiled sleeve bearing or antifriction bearing offers. But for certain types of machines which do not receive attention or where operating conditions will not permit lubrication maintenance, oilless bearings are available which will serve almost as well.

Acknowledgment is made to the following for assistance in the preparation of this article: B. F. Goodrich Co.; Westinghouse Electric & Mfg. Co.; Gatke Corp.; Randall Graphite Products Co.; Graphite Metallizing Corp.; and Neveroil Bearing Co.

Operation Influences Gear Design

(*Continued from Page* 38)

of judgment with past experience the governing factor.

Next of importance in the determination of the service factor is the prime mover. The three classes in Table I have been arbitrarily set up to group prime movers by their relative smoothness of power. Electric motors are normally considered as developing uniformly smooth power. However, transient conditions due to fluctuating voltage supply may result in a pulsating torque.

The curves shown in *Fig.* 3 would seem to justify the general thought behind the practice of using larger service factors for drives employing single-cylinder gas engines as compared with a motor or turbine which has a smooth flow of power. The peak impulse torques indicate a much wider spread than the derating curve factor; however, the addition of flywheels may bring them more in line. Here again, each case should be reviewed on its own merits as present day manufacturing methods may produce a single-cylinder engine of smoother characteristics than an older multicylinder type. It is also a general practice for engine builders to vary the size of flywheel with the duty cycle, thus fundamentally changing its torque fluctuations.

The final influencing factor included in the table of application service factors is that of duration of service. From a theoretical standpoint, at least, speed reducers should have indefinite life since they are loaded within the endurance limit of the material. Careful consideration of this statement reveals the need for evaluating other factors influencing life such as: Abrasion, fluctuations in load, and maintenance.

To reduce hazardous application to a minimum, engineers of the helical and herringbone speed reducer group have "pooled" their experience as a start toward the ultimate goal—that of listing specific applications under the character of load classification which most reasonably applies for normal operating conditions. Such a listing is shown in Table II. No claim is made for completeness and, undoubtedly, experience may dictate some reclassifying.

If it were possible to obtain actual load data, it is believed less trouble would result in applying speed reducers. However, it is the writer's opinion that too often "assumed" loads are being confused with "actual" loads, and "rating" of the prime mover confused with its "capacity". Certainly, the safest practice would be to determine the maximum torque variations from the particular prime mover involved and select the gear reducer large enough to absorb the peaks without distress. Transmission engineers are rapidly realizing the sound engineering principles connected with this practice.

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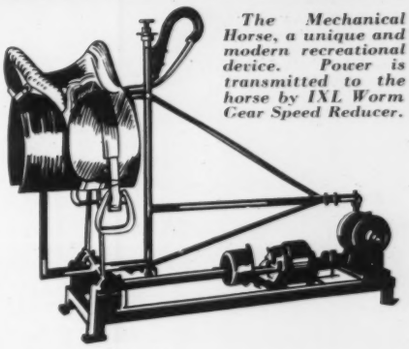

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Business and Sales Briefs . . . . . .

OPENING of a Detroit office in the New Center building, Second boulevard, and Lothrop avenue, has been announced by General Plastics Inc., North Tonawanda, N. Y. The office is in charge of J. S. Miller.

* * *

Harvey T. Harrison, for several years in charge of sales in the Cleveland territory for the Duraloy Co., Scottsdale, Pa., has been appointed sales manager, with offices at Scottsdale.

* * *

Roloff Engineering Co., 610 West Michigan street, Milwaukee, has been appointed as representative of Ajax Flexible Coupling Co., Westfield, N. Y., in the Milwaukee territory.

* * *

For several years vice president of Summerill Tubing Co., and for twenty years prior to that associated with Pittsburgh Steel Co., J. P. Boore has been appointed assistant general sales manager of Babcock & Wilcox Tube Co., Beaver Falls, Pa.

* * *

Garlock Packing Co., manufacturer of mechanical packings, is celebrating its fiftieth anniversary. General offices and factories are located at Palmyra, N. Y. the company has sales offices and warehouses in all principal cities throughout the country.

* * *

C. J. Weigel, 626 East Thirty-fifth street, Brooklyn, N. Y., has been appointed sales manager in the New York district for Braeburn Alloy Steel Corp., Braeburn, Pa.

* * *

Cutler-Hammer Inc., Twelfth and St. Paul avenue, Milwaukee, has announced the opening of a new office in Youngstown, O., located at 1106 Central Tower, and in charge of E. J. Cove.

* * *

Appointment of Burklyn Machinery Co., Syracuse, N. Y., as general distributor in that city for Pioneer Engineering & Mfg. Co. Inc., 31 Melbourne avenue, Detroit, producers of coolant and lubricant pumps, has recently been announced.

* * *

J. J. Summersby, assistant vice president of Northington Pump & Machinery Corp., Harrison, N. J., has been made general sales manager of that corporation. Mr. Summersby joined the company in 1920 as sales engineer and has been continuously identified with it since then as district sales manager, divisional sales manager and assistant general sales manager.

* * *

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Fig. 232

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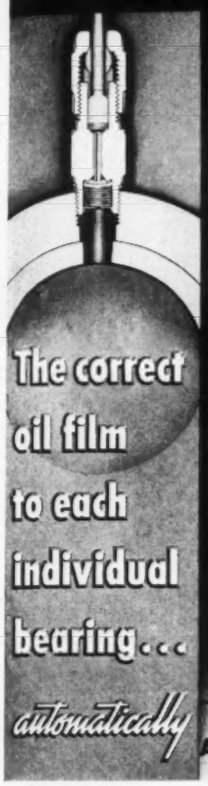

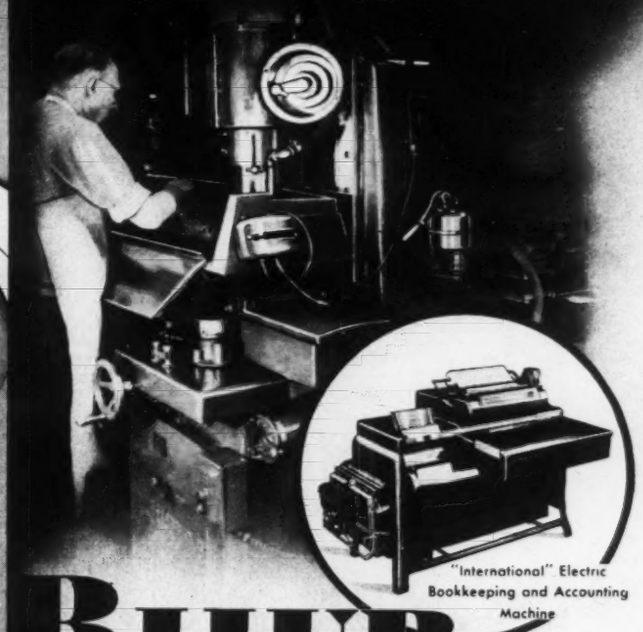

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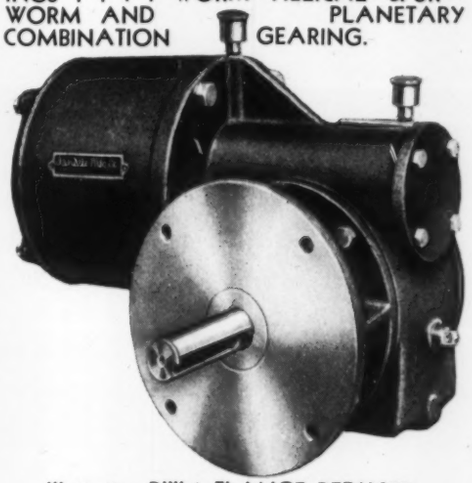

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